The Glass Industry

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Heat Balance for a 25-Ton Glass Tank

By F. J. DENK

[The proper design of a glass furnace necessitates the calculation of the amount of heat needed to melt and fine a desired quantity of glass in the shortest time consistent with economy and quality of the finished product. A well-built furnace is constructed so that it will yield the necessary amount of heat, no more and no less. The efficiency of even the most modern and best built furnaces is not much over 10 per cent. A great many do not do as well as that. Without a financial balance sheet it would be difficult to ascertain whether a concern is run economically or wastefully. The same applies to the furnace and it is with the purpose of outlining a "heat balance" that the following article was written. It is important to know how great a percentage of the heat is needed for the production of the glass, how much is required to heat the tank blocks or pots, and how much is lost or wasted. Some of these losses are avoidable. The furnace builder should know wherein the losses consist, where waste is heaviest, to be able to remodel his furnace to minimize them.—Editor.]

The glass manufacturer is always able to fall back on his financial statements as far as monetary transactions are concerned; he makes a careful analysis of his labor and overhead cost, but how much does he know about the cost of his energy? In most cases the cost for the latter will be guessed at, because there is not very much information on hand which would permit him to make an intelligent analysis of his manufacturing expenses. The reason for this condition is that there are hardly any reliable data available in the technical literature which would permit the calculation of a correct heat balance. Some assumptions will have to be made anyway, but an approximation arrived at by calculation and based upon experimental data always represents an advance beyond a guess.

The data on which the following calculations are based have been collected by the writer in a normally operated plant. No attempt was made to obtain "show"-data, by means of which a favorable heat balance could be arrived at. As the main reason for the publication of the heat balance is to show the conditions as they prevail in many of the medium sized and small sized glass plants, the conclusions, drawn at the end of the article show where improvements can be and should be made in order to effect a saving in fuel and, therefore, in energy.

The units used in the following are those of the English system. The writer is well aware of the fact that metric units are being used more and more in scientific papers in this country and he himself is very much in favor of applying the metric system to calculations of this kind, but there are some very important reasons which induced him to use the English units. The men in practice, as far as factories of the kind named above are concerned, are familiar with British thermal units[1] but the metric units are unknown to them. Besides, the heating values of the coal and the gas are always expressed in B.t.u's, and it was therefore thought advisable to carry the whole calculation through with these units.

The following test data have been used, which, as far as necessary, refer to 62° F. and 30 in. mercury:

Size of producer (inside diameter)	10 ft. 0 in.
Coal gasified per hour, 16 lbs. per square foot, or about ... per hour	1250 lbs.
Temperature of gas leaving producer	1350° F.
Length of flue (overhead, not covered)	250 ft.
Drop in temperature through flue, 2.5° per foot, or ... total	625° F.
Temperature of gas entering valve	725° F.
Temperature of gas leaving regenerator	1500° F.
Temperature of air entering valve	100° F.
Temperature of air leaving regenerator	1500° F.
Furnace temperature	2600° F.
Moisture in gas ... per cu. ft.	30 grains
Moisture in air required for combustion ... per cu. ft.	7 grains
Steam blown ... per lb. coal	.3432 lb.
Temperature of waste gases entering regenerators	2200° F.
Temperature of waste gases leaving valves	700° F.

Coal, ash, soot analyses and gas analyses were made in a laboratory.

All the temperatures were taken with a platinum-platinum-rhodium pyrometer, which was located in such a way that it reached right into the current of the hot gases. For this reason, these temperatures represent the actual gas temperatures and not the temperatures of the brick work, although it is possible that the temperatures have been influenced to a small extent by the heat radiated from the walls.

[1] A British Thermal Heat-Unit (B.t.u.) is that quantity of heat required to raise one pound of pure water one degree Fahrenheit at or about 39.1° F.

(1) *Coal Analysis.*

Carbon (C)	79.07 per cent	
Hydrogen (H_2)	5.25 per cent	
Oxygen (O_2)	7.68 per cent	Moisture, 2.00 per cent.
Nitrogen (N_2)	1.40 per cent	Heating value, 13,779 B.t.u. per lb.
Sulphur (S)	1.00 per cent	
Ash	5.60 per cent	
Total	100.00 per cent	

Ash analysis: Ash 88.5 per cent, ignition loss (90 per cent C.), 11.5 per cent.

Soot analysis: C. 82.56 per cent.

(2) *Gas Analysis.*

Carbon monoxide (CO)	24.14 per cent	Heating value 137.45 B.t.u. per cu. ft.
Methane (CH_4)	2.40 per cent	
Ethylene (C_2H_4)	.26 per cent	Moisture in gas, 30 grains per cu. ft.
Hydrogen (H_2)	12.04 per cent	
Carbon dioxide (CO_2)	5.62 per cent	Steam blown, including moisture in air entering producer, .3432 lb. per lb. coal.
Oxygen (O_2)	.10 per cent	
Nitrogen (N_2)	55.44 per cent	
Total	100.00 per cent	

(3) *Amount of Gas Made Per Pound of Coal Gasified.*

Total carbon in coal	.7907
Carbon lost in ashes	.0063
Carbon lost in soot	.0693
Total carbon lost	.0756

And total carbon gasified, .7907 — .0756 = .7151 lb. per lb. coal.

The amount of carbon lost in ashes is obtained from the ash analysis, whereas the amount of carbon lost in soot must be determined in a more complicated way. The test made for the determination of the amount of soot in the gas gives the quantity contained in one cubic foot. The total quantity of gas, however, depends upon the pounds of carbon gasified, and these, in turn, partly on the amount of carbon lost in the soot. We are, therefore, moving around in a circle, to get out of which a lengthy calculation has to be made, which, however, will not be shown here.

The total amount of carbon gasified per pound of coal must appear in the gas generated from one pound of coal. The carbon-containing constituents in the gas are:

Carbon monoxide (CO)	.2414 per cent by volume
Carbon dioxide (CO_2)	.0562 per cent by volume
Methane (CH_4)	.0240 per cent by volume
Ethylene (C_2H_4) .0026 x 2	= .0052 per cent by volume
Total	.3268 per cent by volume

The ethylene, C_2H_4, must be taken twice, because it contains two atoms of carbon.

In order to obtain the amount of gas made, this figure must be multiplied by the weight of one (hypothetical) cubic foot of carbon. This weight can easily be obtained by subtracting the weight of one cubic foot of oxygen from the corresponding weight of carbon dioxide or carbon monoxide, viz.:

Weight of carbon dioxide (CO_2)	.1159 lb.
Weight of oxygen (O_2)	.0843 lb.
Weight of one cubic foot of carbon (C)	.0316 lb.
Or,	
Weight of carbon monoxide (CO)	.07375 lb.
Weight of oxygen (O)	.04215 lb.
Weight of one cubic foot of carbon (C)	.03160 lb.

This weight is multiplied by the quantity of carbon-containing constituents and the product is divided into the total carbon gasified per pound of coal. The result will be the quantity of gas in cubic feet obtained from one pound of coal, or

$$\frac{.7151}{.3268 \times .0316} = \frac{.7151}{.01032688} = 69.24 \text{ cu. ft.}$$

of gas made per pound of coal gasified.

(4) *Amount of Air Blown Per Pound of Coal.*

Nitrogen in gas ..... .5544 per cent

From this the total amount of air blown into the producer is obtained in the following way:

$$\left(\frac{N_2}{3.78} + N_2\right) \times .5544 \times 69.24 = 1.265\ N_2 \times .5544 \times 69.24 =$$

48.5 cu. ft. per lb. coal,

3.78 being the ratio of oxygen and nitrogen (by volume) in the air.

After having determined the producer data, we can start with the heat balance by first determining the total amount of heat put into the producer.

(A) EFFICIENCY OF THE PRODUCER

(a) *Heat in the Coal.*

Heat value of coal ..... 13,779 B.t.u. per lb.
Amount of coal gasified ..... 1,250 lbs. per hr.
Or .....30,000 lbs. per 24 hrs.
Total heating value of coal in 24 hrs.,
13,779 x 30,000 = 413,370,000 B.t.u.

(b) *Heat in the Steam*

Amount of steam blown ..... .3432 lb. per lb. coal
Total amount of steam blown in 24 hours ..... .3432 x 30,000 = 10,296 lbs.
Heat in steam at 212° F. ..... 1150.4 B.t.u. per lb.
Total heat in steam in 24 hours,
1150.4 x 10,296 = 11,844,518 B.t.u.

In regard to this last calculation the objection may be raised that the steam is at 40 to 60 lb. gauge pressure and its temperature, therefore, over 212° F. But it must be kept in mind that this steam expands suddenly to atmospheric tension or even less, so that the temperature of the expanded steam is close to 212° F. The writer has many times determined the temperature of the steam-air mixture when it leaves the blower and has found it to vary between 160 and 190° F., according to the original steam pressure applied. There is, therefore, no mistake made when calculating the heat in the steam at atmospheric pressure.

The total input into the gas producer is now:

413,370,000 + 11,844,518 = 425,214,518 B.t.u. per 24 hrs.,
Or, 100.00 per cent.

(c) *Heating Value of the Gas Made.*

Amount of gas made per pound of coal ..... 69.24 cu. ft.
Total quantity made in 24 hrs.,
69.24 x 30,000 = 2,077,200 cu. ft.
Heating value of gas ..... 137.45 B.t.u. per cu. ft.
Total heating value per 24 hrs.,
137.45 x 2,077,200 = 285,511,140 B.t.u.

(d) *Sensible Heat in Gas.*

Temperature of gas leaving producer ..... 1350° F.

The sensible heat in the gas must be figured from sensible heat of the constituents.

Hydrogen (H_2) ..... .1204
Nitrogen (N_2) ..... .5544
Oxygen (O_2) ..... .0010
Carbon monoxide (CO) .2414

.9172 x (.0189 t + .00000093 t^2) = .0173 t + .000000853 t^2,

Carbon dioxide (CO_2) .0562
Methane (CH_4) 0240

.0802 x (.023 t + .0000076 t^2) = .0018 t + .000000610 t^2,

Ethylene (C_2H_4) ..... .0026 x (.029 t + .0000104 t^2) = .0001 t + .000000027 t^2

Adding

.0173 t + .000000853 t^2
.0018 t + .000000610 t^2
.0001 t + .000000027 t^2

Gives the total .0192 t + .000001490 t^2
and for 1350° F. we have

.0192 x 1350 + .00000149 x 1350 = 28.65 B.t.u. per cu. ft.

Total sensible heat in gas
28.65 x 2,077,200 = 59,511,780 B.t.u.

(e) *Heat in Moisture in Gas.*

Amount of moisture in gas, 30 grains per cu. ft., or $\frac{2.077,200 \times 30}{7000} = 8902$ lbs. or

$\frac{8902}{.04745} = 187,610$ cu. ft. per 24 hrs.,

where .04745 = weight of one cubic foot of water vapor.

$187,610\ (.021 \times 1350 + .0000052 \times 1350^2) =$
$187,610 \times 37.35 = 7,007,286$ B.t.u.

Total sensible and latent heat in gas and moisture
285,511,140 + 59,511,780 + 7,007,286 = 352,030,206 B.t.u. per 24 hrs.

furthermore, forms crusts on the bricks which by and by are going to sinter together and close up the passages. The final result will be that no melting heat will be obtained any more; the furnace must be shut down and the chambers reset.

This trouble can be avoided when the batch is sprinkled with a little water. This water, of course, must then be evaporated, which requires a certain quantity of gas.

The total moisture contents in the batch, including the moisture contained in the raw material and that added later, amounts to about 5 per cent.

The amount of glass made from 1,000 pounds of batch of a composition as shown above, is shown in table No. 1. The table shows that from 1,000 pounds of raw material, 779 pounds of glass are obtained, shrinkage amounting to over 20 per cent.

TABLE No. 1

SHOWING DISTRIBUTION OF RAW MATERIAL

		Glass Forming Material			Gases Generated, Lbs.		
Name	In 1,000 lbs.	Constituents	Amount, lbs.		CO_2	SO_2	H_2O
Sand SiO_2	548	SiO_2		548			
Limestone, $CaCO_3$	165	CaO	165 x .56 =	92	165 x .44 = 73		5% in
Soda, Na_2CO_3	140	Na_2O	140 x .58 =	82	140 x .415 = 58		Batch = 50
Salt cake, Na_2SO_4	130	Na_2O	130 x .437 =	57		130 x .451 = 59	
Charcoal, C	17	C			17 x 3.67 = 62		
Total	1,000 lbs.			779 lbs.	193 lbs.	59 lbs.	50 lbs.

Producer efficiency

$\frac{352,030,206 \times 100}{425,214,518} = 82.78$ per cent

Loss in producer: 100.00 — 82.78 = 17.22 per cent.

(B) LINE LOSSES.

Temperature of gas and moisture leaving producer 1350° F.
Temperature of gas and moisture entering reversing valve 725° F.

On account of the general layout of the tank it was not possible to determine the temperatures at the regenerating chambers. The valves, however, were located so close to the chambers that they actually could be considered as part of them as far as preheating was concerned.

Sensible heat in the gas at 1350° F..... 59,511,780 B.t.u.
Sensible heat in moisture at 1350° F..... 7,007,286 B.t.u.

Total at 1350° F..... 66,519,066 B.t.u.

Sensible heat in gas at 725° F.

$(.0192 \times 725 + .00000149 \times 725^2) \times 2,077,200 =$
$2,077,200 \times 14.59 = 30,306,348$ B.t.u.

Sensible heat in moisture at 725° F.

$(.021 \times 725 + .0000052 \times 725^2) \times 187,610 =$
$187,610 \times 17.96 = 3,369,476$ B.t.u.

Total sensible heat at 725° =
30,306,348 + 3,369,476 ..... 33,675,824 B.t.u.

Heat lost in gas main ..... 32,843,242 B.t.u.

or

$\frac{32,843,242 \times 100}{425,214,518} = 7.72$ per cent.

(C) COMPOSITION OF THE BATCH

1,000 pounds of batch contained

Sand (SiO_2)	548 lbs.
Limestone ($CaCO_3$)	165 lbs.
Soda (Na_2CO_3)	140 lbs.
Salt cake (Na_2SO_4)	130 lbs.
Charcoal (C)	17 lbs.
	1,000 lbs.

The raw material contained only small amounts of impurities which, therefore, can be neglected in the calculation.

When charging the batch into the tank, dust will easily be created, which will be carried away by the stack draft. This not only causes a loss in material, but it is also detrimental to the chambers, because the dust will settle on the checker bricks which thus become glazed. This reduces the heat exchange and,

The composition of the glass is as follows:

548 : 60 = 9.13 SiO_2 (Silica),
92 : 56 = 1.64 CaO (Lime),
82 + 57 = 139 : 62 = 2.24 Na_2O (Sodium oxide),

where 60, 56 and 62 are the molecular weights for SiO_2, CaO and Na_2O, respectively.

Reduced to 1 CaO, we have

9.13 : 1.64 = 5.57 SiO_2,
1.64 : 1.64 = 1.00 CaO,
2.24 : 1.64 = 1.36 Na_2O.

(D) AMOUNT OF GLASS MADE IN TWENTY-FOUR HOURS.

Fourteen carloads of batch were charged into the tank in 24 hours, each car holding 3,300 pounds, including the cullet. This amounts to 46,200 pounds of batch and cullet. Since the cullet is about 20 per cent of the batch, we have

$\frac{46,200 \times 100}{120} = 38,500$ lbs. of batch and 7,700 lbs. of cullet.

Since from 1,000 lbs. of batch 770 lbs. of glass were obtained, the total amount of glass made was

$\frac{779 \times 38500}{1000} =$ approximately 30,000 lbs. of glass, which, including the cullet, give a total of 37,700 lbs. of glass.

The total quantity charged in 24 hours is

Sand	548 x 38.5 =	21,098 lbs.
Limestone	165 x 38.5 =	6,352 "
Soda	140 x 38.5 =	5,390 "
Saltcake	130 x 38.5 =	5,005 "
Charcoal	17 x 38.5 =	655 "
Total		38,500 lbs. per 24 hrs.

not including the cullet.

(*Continued in the July issue*)

Use of Powdered Glass

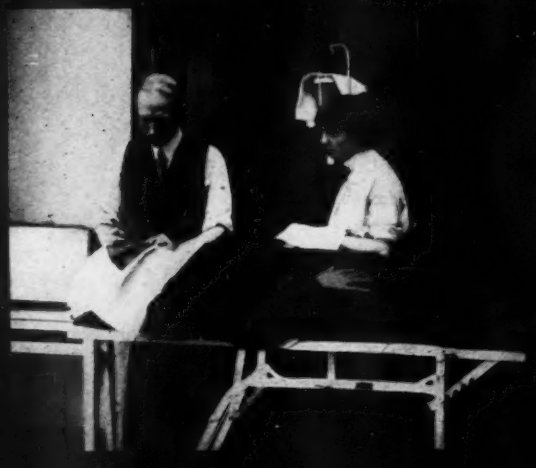
Fifty years ago throttle valves were ground in their seats with powdered glass, as this material was considered an efficient abrasive for the purpose. The seats were bored carefully to the desired angle while the valve body was turned to a nice fit. Glass was used to make a steam tight joint. When a locomotive came to the shop for a general overhauling it generally was necessary to regrind the throttle valve. At the present time, throttle valves are ground by the same method, but carbide of silicon has taken the place of glass.—W. C. Read, in *Abrasive Industry*.

GUARDING THE HEALTH OF ITS EMPLOYEES

Scenes in the Medical Department of a Modern Glass Factory where it has been found that protective measures pay.

Some of the results attained by medical supervision of the health of employees: Health, working abilities and morale of the factory personnel improved, confidence and loyalty increased, workers are given tasks suited to their physical condition and ability, their productive years are increased, results of accidents are minimized by prompt treatment, infections prevented, epidemics avoided, safety measures are developed, sanitary conditions improved in factory and homes, lives are made happier and more useful. This conservation of man- and woman-power results in reduced labor turnover and per capita production increased and maintained at the highest possible level.

The illustrations show how Dr. George F. Greenleaf, medical director of the Illinois Glass Company, Alton, Ill., and his staff minister to the needs of the Company's employees. An article by Dr. Greenleaf on "The Influence of the Medical Department on Production" appeared in the May issue.



Electrical Removal of Dust from Producer Gas*

In glass factories using producer gas a number of appliances have been used for many years with the object of removing finely divided particles which are carried along with the gas in the form of dust. These impurities consist primarily of ashes from the producer, dust which is carried by the compressed air and soot formed by the decomposition of the fuel. The quantity of dust differs greatly, depending, for instance, on the kind of fuel used, its moisture contents, the pressure of the air and the method of charging the producer. Quantitative estimations have given amounts of dust varying from 2 to 18 grams per cubic meter of gas reduced

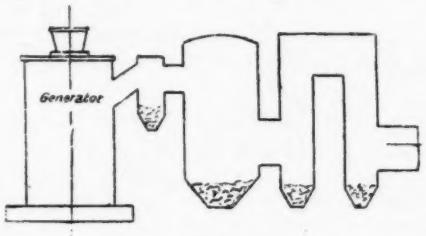


FIG. 1

to 0° C and 760 mm. of mercury. For instance, briquettes made of lignite yielding about three cubic meters of gas per kilogram with a dust content of 10 grams per cubic meter, and of which 20 tons were gasified per 24 hours gave

$$\frac{20{,}000 \times 3 \times 10}{1{,}000} = 600$$

kilograms of dust, which occupied about one-half cubic meter of space. It is easy to see that such quantities of dust, if not removed, would rapidly diminish the available space in the gas flues, and that trouble is unavoidable unless care is taken to separate and remove the dust. It is very probable that most defects in regard to purity and color of the glass can be traced back to dust which enters the oven with the gas. The problem of dust removal therefore deserves close attention.

The cleaning of producer gas is usually accomplished by diminishing the speed of the gas, through enlargements of the gas flues into dust chambers, and through changes in the direction of flow of the gas.

Figure 1 represents an installation for dust removal as described.

In recent years articles have appeared in technical journals which describe a process of gas purification by electricity. Numerous papers on this subject have been read before meetings of technical societies and the good results reported to have been obtained by this method of dust removal in different industries make it desirable that the glass industry should become interested in this process.

Electrical purification is based on conducting the gas through an electric field of high tension. This field exists either in pipes having wires along the axis, or between metal plates between which wires are placed. Electricity in the form of a spray is discharged from the wires, and throws all solid or vapor (liquid) particles against the walls of the tubes or the plates. The particles are deposited there for a short time and fall down in the funnel, when the precipitate has become sufficiently heavy. The gas flows in a purified condition from the electric field and the precipitated impurities fall on the dust collector, from which they can be removed in different ways, by means of conveyors, cars, etc.

The electric high tension field is usually made by means of an intermittent direct current, made by rectifying an alternating current. The rectifying of the current and its intermittence is effected usually by means of a rotating circular plate, covered with metallic discs. The number of current pulsations is twice as large as the number of cycles of the alternating current, from which the direct current is made. The number of cycles in use in Germany being 50, it follows that 100 direct current pulsations occur every minute, causing the electric field to be formed and to disappear an equal number of times. The gas, exposed to the intermittent electrical discharges, is freed from all dust.

Although this process, which is based on the American Cottrell's patents and on the German Moeller patents, is comparatively new (the first large installations were built shortly before the war) it has been well received by various industries. At the present time there are about 60 installations in Germany. In other countries there are about 200, one-half of which are located in the United States. Until recently the system has been used almost exclusively in metallurgical,

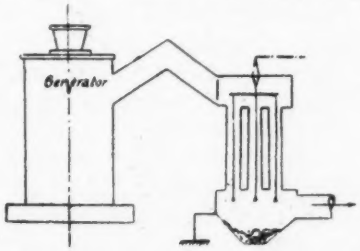


FIG. 2

cement, carbide and chemical works. Lately blast furnace and producer gases are being purified by means of the Cottrell-Moeller precipator.

The efficiency of the system amounts to over 99 per cent; i.e. 99 per cent of the dust present in the gas is removed so that after leaving the apparatus only traces of impurities remain. In many cases so little dust is left that it can scarcely be estimated by common methods.

Although high tension is used, yet the handling of the machinery is very simple. Workmen are not exposed to danger because the parts which are highly charged are not accessible, and also on account of the low amount of current used, being only a few milli-amperes, the thousandth part of an ampere. In spite of the considerable number in use, no serious accident due to short circuit has occurred.

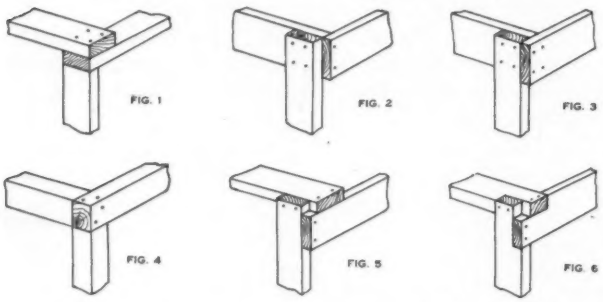
The power requirements of the installation amount to a few kilowatts and can, for instance, be generated by using waste heat, which would be especially available in glass factories. It is desirable that the glass industry should investigate and make practical experiments with electrical purification of producer gas.

*_Sprechsaal_, Vol. 55 (1922), pp. 145, 146.

The Crate Corner*

The corner is the weakest part of the ordinary crate. Some facts about crate corners observed in tests at the Forest Products Laboratory may be of assistance to crate builders in strengthening this weak part by better arrangement of members and methods of nailing or bolting.

An example of inexpert crating frequently met with



is that shown in Fig. 1. This construction is poor because the nails holding one member are driven into end grain and so have comparatively low holding power. Another common example of the same fault is shown in Fig. 2. This construction may be improved (Fig. 3) by lengthening the member to permit nailing into the side grain.

The corner construction shown in Fig. 4 is very weak, because the only nailing possible is through one member into the end grain of the other two. This style of corner is frequently used in crates which are to be entirely covered with sheathing. In a crate without sheathing it would, of course, be worthless.

In Fig. 5 each member is nailed to another member and has the third member nailed to it. This is a very effective arrangement. It is called the "3-way" corner, and the distinguishing feature is that each member is held by nails or bolts in two directions. Fig. 6 is suggestive of further variations of the 3-way principle, with the members notched together.

Seldom if ever does the 3-way corner construction increase the volume of the crate. On the contrary, it usually reduces the space occupied. When properly nailed or bolted, this type of corner has a considerable bracing effect, although it does not do away with the need for diagonal bracing.

The sixteen possible arrangements of members at a 3-way corner are given in Fig. 7. It will be seen that A and I are most practical when the object to be crated is a box-like form, such as a filing case. When the object is of irregular form, such as an electric motor, one of the other arrangements may have the advantage of permitting better bracing and blocking.

ARRANGEMENT OF MEMBERS AT 3-WAY CORNER

Proper arrangement of members will not in itself produce a good corner. They must be properly fastened together. Whether bolts or nails should be used depends principally on (1) the thickness of the members, (2) the amount of stiffening afforded by sheathing, and (3) labor costs.

NAILING

Nails driven in holes slightly (1/32 to 1/16 inch) smaller than their diameter have considerably more resistance both to direct pull and to shear than nails driven without holes.

Cement coated nails are superior to uncoated nails.

Length of nails should be somewhat more than twice the thickness of the member holding the heads.

Slender nails are likely to hold better than thick nails under the repeated shocks and constant weaving action to which crates are subjected, because the slender nail bends near the surface of the pieces joined without loosening the friction grip towards the point.

Number of nails or bolts joining one member to any other member should not be less than two. Usually

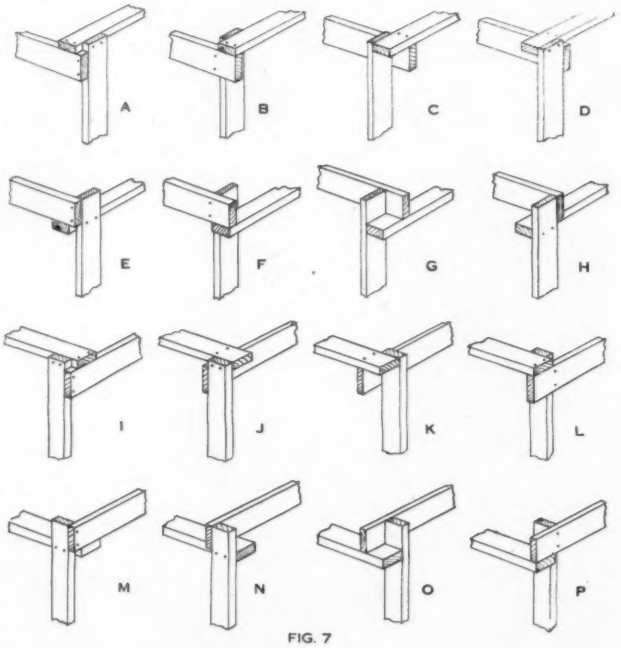


FIG. 7

as many nails as can be driven without splitting should be used.

Danger of splitting will be reduced if nails are staggered. Boring holes for nails also reduces the danger of splitting.

BOLTING

Bolts have the advantage of holding after the friction grip of the wood on the shank is destroyed. The following schedule of bolt sizes is suggested as a guide:

Thickness of crate members	Diameter of bolts
Up to 1½ inch	⅜ inch
1½ to 3 inches	½ inch
3 to 5 inches	⅝ inch

Machine bolts should have washers and the heads should be countersunk. Carriage bolts are preferred to machine bolts and may be used without washers.

* Technical Note No. 134, Forest Products Laboratory, U. S. Forest Service, Madison, Wis.

Pyrex: A Triumph for Chemical Research in Industry*

By W. H. CURTISS†

What does the word "glass" mean to the ordinary man? He thinks of a hard, transparent substance easily broken. These two properties, transparency and breakableness, are universally connected with glass in the public mind. To be sure, not all glass is transparent; but transparency governs the most familiar uses of glass and it may be regarded as its most important property. Ease of breakage, on the other hand, is and always has been a basic handicap in glass, and has profoundly influenced the character of its uses. So inseparable from glass has this quality been regarded that until recently glass manufacturers gave no serious thought to the possibility of modifying the extent to which glass, under various conditions, is breakable.

The first deliberate study and efforts by a manufacturer of glass in the United States to produce a glass of superior mechanical strength and with real qualities of heat and chemical resistance were made by Corning Glass Works of Corning, New York. The Corning Glass Works had the specific problem to solve of devising a glass for the inner globe of street arc lamps that would resist the intense heat generated by the arc and the extreme temperature variations incident to outdoor use, and its efforts were at first instigated by this problem. There was little to guide them in their study. The pioneer work of Otto Schott of Jena had shown that of the six factors or properties determining the ability of glass to withstand sudden changes in temperature the linear expansion coefficient could be most easily and widely varied. Disregarding quartz glass and speaking only of glasses that can be melted and worked by usual methods, the expansion of glass can be varied in the ratio of six or more to one. The other properties influencing heat resistance cannot be varied over any such range. Corning's line of research, therefore, was toward a glass of low linear expansion; but in securing that property the composition could not be varied in directions that would adversely affect the melting and working qualities of the glass.

Glasses having expansion as high as 0.000014 have been made without difficulty. Ordinary lead glass has an expansion of 0.0000092, while lime glass has a somewhat higher coefficient. When Corning Glass Works commenced its experiments, a Jena glass was known having an expansion coefficient of 0.0000064. This was the Jena thermometer glass 59''' and was a borosilicate glass. Here then was one indication that assisted the early experiments—the glass known at the time that had the lowest coefficient of linear expansion was a borosilicate glass.

The Jena 59''' glass and other glasses having somewhat similar properties were tested and analyzed; and glasses duplicating these properties were manufactured on a small scale. At first the commercial application was limited to inner arc globes and battery jars; but later the glass was applied also to railroad lantern globes, the need having long been felt for a heat resisting glass to meet the severe service exacted of such globes. These early glasses of Corning were successful to an extent that justified the company in establishing the first properly organized research laboratory in the glass industry in the United States.

The laboratory organization carried on in a more intensive fashion the work already started in modifying the known borosilicate glasses in the direction of lowering their expansion. One of the chief difficulties experienced was the maintenance of stability in the glass as the expansion was lowered. Efforts were concentrated on this problem with the result that a glass was soon developed combining low expansion with sufficient stability so that it became the standard for lantern globes, chimneys, inner arcs, and battery jars, practically eliminating from the market ordinary glass previously used for these products. To this glass the trade-mark Nonex was applied. The application of the glass to railroad lantern globes demanded a separate line of research to develop suitable colors for standard railroad signal work. Much of this research was in distinctly new channels, because the usual materials for producing red, green, blue, and yellow hues had a radically different effect when introduced into the new heat resistant composition. It is sufficient to say that this problem was completely solved and that all the standard railroad colors are regularly produced in Corning low expansion glasses.

The steady progress made by Corning Glass Works' laboratory toward the definite goal that had been set from the beginning of their research, and the great commercial success attained with the heat resisting glass products that had been marketed, paved the way for what was perhaps the most daring and most distinctly novel idea for an application of heat resistant glass that had yet been made—the use of it as a material for oven cooking utensils. To attain any measure of success in this field it was necessary to intensify and increase all of the effects already secured in the new glass. The heat resistant quality must be improved, for a thick walled baking dish subjected to oven heat represented a severer test than any service required of lantern globes or chimneys; it must have still greater resistance to the corrosive action of liquids; and it must be strong enough mechanically to stand the rough usage of the ordinary kitchen. The first large shipment of baking ware, now known throughout the world as Pyrex, was made by Corning Glass Works in May, 1915, after several years of intensive study and experiment and after wide distribution of such ware made for test purposes.

During the year 1914, a new commercial application for this versatile glass, of vital significance to the chemical industry, was undertaken in a small way. In that year flasks, beakers, and laboratory apparatus were first made. As has been pointed out, development of a successful oven cooking glass had necessitated great improvement in heat resistance and nonsolubility. These very qualities gave, ready to hand, a laboratory glass superior to any known glass, foreign or domestic. American laboratories, both industrial and educational, had long depended for their glass apparatus on the foreign makers. Jena glasses had been regarded as the

* *The Journal of Industrial and Engineering Chemistry*, Vol. 14, No. 4.
† Corning Glass Works, Corning, N. Y.

standard of the world in this field; but when the war caused the gradual drying up of imports from Germany, Corning was fully prepared to help the American chemist in his difficulty. Chemists throughout the country, knowing of the remarkable properties of Pyrex from its other demonstrated uses, virtually demanded it for their laboratories; and the Government itself seconded this demand when war industry and research enormously increased the use by the Government of chemical glassware. It was in the spring of 1915 that Corning placed on the market a complete line of flasks, beakers, test tubes and fabricated apparatus in Pyrex—a line that has grown steadily in popularity till now scarcely a laboratory in the country is without its quota of Pyrex chemical ware. Foreign chemists, too, have recognized the value of Pyrex, which is now invading the home markets of the best foreign glass in steadily increasing quantities.

Pyrex should not be regarded as a *substitute* for the glasses of Jena and other foreign laboratory-ware makers. By test and by the expression of thousands of chemists it is distinctly superior to these glasses, and has supplanted them on its own merits. The United States Bureau of Standards[1] gives to Pyrex a higher rating than to any other known glass. Details of the tests by which this rating was determined need not be repeated here except to say that the linear expansion of Pyrex was found to be 0.00000334, of the best foreign glass 0.00000479; while the solubility of Pyrex in water was less than half that of the foreign product.

To dismiss in these few paragraphs the intensive development and research preceding the year 1915 gives an entirely inadequate picture. Aside from continued progress along the main research path—the lowering of expansion and improving of stability in the glass itself—there were other major problems arising from its radically different melting and working conditions. It was decidedly more refractory than ordinary glasses, requiring an exceptionally high temperature for melting. The highest skill in the art of glass melting was required to perfect the commercial production of Pyrex on a large scale. This same refractory quality meant that the glass "set" more rapidly than softer glasses, and quicker methods of working and handling had to be devised.

Mention should here be made of the discovery of a very important property of glass in its use as baking ware. It bakes food more rapidly and thoroughly than ordinary utensils of metal. This was found to be due to the greater reflectivity of the metal for radiant energy. It has been determined that silver reflects about 90 per cent of radiant heat rays, while glass reflects only about 14 per cent. Ordinary utensil metals would be lower in reflectivity than silver, but still comparable to it and very much higher than glass. A series of experiments demonstrated the practical importance of this property of glass as a baking utensil and its superiority to any other oven utensil in commercial use.

It should be borne in mind that research work for improving Pyrex and for widening its commercial uses is by no means finished; in fact, the present applications of Pyrex, diverse as the appended list shows them to be, are believed to represent only a beginning of the possibilities in this remarkable glass; and Corning's laboratory organization is making constant progress in perfecting new uses for it. Of particular interest to the chemical industry will be the logical step from the laboratory use of Pyrex to actual production uses in chemical manufacturing plants. It is confidently expected that Pyrex products will soon replace more expensive and less reliable materials in chemical plants for conveying liquids at high temperatures, for volatilization and for kindred uses.

The scope of the present article will not permit of a detailed treatment of the many other eminently successful lines of research by the laboratory of Corning Glass Works. The development of Pyrex is only a typical example of the contributions of that organization to glass chemistry. Brief mention may be made, however, of the most important of those contributions which have placed America in a leading position in the manufacture of glass for various practical, industrial, and scientific uses. Potash glass was formerly considered essential for incandescent electric light bulbs. The war, by shutting off imports of German potash, made action imperative in the direction of a substitute glass. First, a successful non-potash lead glass was produced, and later a lime glass, which has largely replaced all other glasses in the making of incandescent bulbs in this country. Colored glasses of various special properties have been developed, embracing the high transmission railroad signal colors; a glass absolutely duplicating daylight; glasses absorbing certain definite portions of the spectrum, such as the ultraviolet or the infra-red rays; X-ray shield glasses; spectacle glasses for work in special conditions of heat and light. Each of these deserves a chapter in the story of chemical research in industry, but must here be dismissed with only this mention.

PRESENT PRODUCTS OF PYREX

Oven cooking utensils	Flasks, Beakers, test tubes
Oven door panels	Fabricated laboratory apparatus
Percolator tops	Battery jars
Coffee urn liners	Lantern globes
Gage glasses	Chimneys
Cylinders	Condenser lenses
Tubing	Headlight glasses

[1]Walker and Smither, "Comparative Tests of Chemical Glassware," *Bur. Standards Tech. Paper*, 107 (April 5, 1918).

Electric Power in Glass Factories

C. W. Fick in the *General Electric Review* gives the following tabulation showing the principal applications of electric motors in a plate glass works and the proportion of the total power which each requires:

Polishers	45 per cent
Grinders	35 per cent
Pumps	10 per cent
Compressors and fans	5 per cent
Conveyors, cranes and hoists	2 per cent
Mixers and agitators	2 per cent
Miscellaneous	1 per cent

If properly motored the power-factor may easily be maintained at 80 per cent or better.

Future developments in the glass industry, insofar as the electrical world is concerned, lie along the lines of direct-connected motors for the grinders and polishers in the plate-glass branch, and of electric furnaces and annealing lehrs in all branches.

The Laboratory

By J. B. KRAK

Analysis of Optical Glasses

The analysis of the majority of optical glasses does not present any special difficulty. However, some optical glasses are more complicated than chemical glassware and require modifications of the procedures outlined for the analysis of that type of glasses.

ORDINARY CROWN.—The main constituents of this variety of optical glass are silica, calcium oxide and both alkalies. Some contain a small amount of barium oxide, and they may also contain minute quantities of alumina and arsenious oxide. The outline for the analysis of common glass[1] may be used. If the glass contains barium, add sulphuric acid to the filtrate from the silica. Filter and weigh as barium sulphate.

$$\text{Calculation: } \frac{\text{Weight of } BaSO_4 \times 65.71}{\text{Weight of sample}} = \text{per cent BaO}$$

In the filtrate, any iron and aluminum present is precipitated with ammonia; lime is precipitated in the filtrate with ammonium oxalate.

BOROSILICATE CROWN contains boric oxide, and occasionally also barium, zinc, or both as oxides, in addition to the usual constituents of common glass. The outline for the analysis of scientific glasses is recommended.[2] If lead is present, it must be separated as sulphide in the acid solution filtered from the silica. The J. Lawrence Smith method for the estimation of the alkalies is the most convenient. It should be remembered that boric oxide goes in solution with the alkalies. It is removed after the precipitation of lime, by evaporation with methyl alcohol.

ZINC SILICATE CROWN.—This type of optical glass contains silica, zinc oxide and alkalies. Estimate silica as usual. Neutralize the filtrate with soda, add an excess of formic acid and precipitate zinc as sulphide. Filter, dissolve the zinc sulphide in hydrochloric acid, neutralize with ammonia. Heat to boiling and add a large excess of di-ammonium phosphate. Filter in a tared Gooch crucible, wash with one per cent di-ammonium phosphate solution and finally with alcohol. Dry, ignite and weigh as zinc pyrophosphate.

$$\text{Calculation: } \frac{\text{Weight of } Zn_2P_2O_7 \times 53.40}{\text{Weight of sample}} = \text{per cent ZnO.}$$

BARIUM CROWN.—This glass contains silica, boric oxide, alumina, zinc oxide, barium oxide and the alkalies. Some varieties also contain lead oxide. The scheme of analysis is a composite of that described for the analysis of chemical glassware[2] and of the outline proposed for the analysis of borosilicate crown containing barium.

FLINTS contain silica, alumina, lime, the oxides of zinc and lead and the alkalies.

BOROSILICATE FLINT contains silica, boric oxide, alumina, lead oxide and small amounts of alkalies.

BARIUM FLINT contains silica, lead oxide, zinc oxide, barium oxide and the alkalies. Lead is gassed out in acid solution with hydrogen sulphide after estimation of silica. Hydrogen sulphide is removed by boiling and barium precipitated with sulphuric acid. In the filtrate, zinc is precipitated with di-ammonium phosphate in neutral solution and weighed as zinc pyrophosphate. Or it may be estimated in acid solution as zinc mercuric thiocyanate.

BORATE GLASSES contain no silica, which is entirely replaced by boric oxide. They contain alumina, lead oxide, and may also contain barium oxide and the alkalies. Boric oxide must be removed by repeated evaporations with hydrochloric acid—methyl alcohol reagent[3]. It is best to estimate boric oxide by distillation as methyl borate and subsequent titration. For details consult the article by E. T. Allen and E. G. Zies, published in the *Journal of the American Ceramic Society,* vol. 1, p. 739 (1918). The method is based on the distillation of the solution containing the boric oxide in a current of boiling methyl alcohol and titration of the distillate with standard sodium hydroxide solution in the presence of mannitol.

ESTIMATION OF IRON.—A very small amount of iron in optical glass lowers the transmission of light and gives a distinct color. Its accurate estimation requires several precautions. Great care must be exercised to prevent contamination of the sample with iron from the outside and to avoid its occlusion in precipitates which must be removed before iron can be determined.

Pulverize the sample in an agate mortar, weigh 5 grams and transfer to a clean platinum crucible. Add 10 cc. of sulphuric acid (1 : 1) and 10 cc. of hydrofluoric acid (40 per cent). Heat until the sample is completely decomposed, which may require additional amounts of both acids. Allow to cool, transfer the residue to a beaker with water and boil for some time. Filter, wash and reserve the insoluble residue, which may contain iron. Gas the filtrate with hydrogen sulphide which removes lead and arsenic, if present. If zinc is present, neutralize the filtrate with soda, add formic acid in moderate excess and gas with hydrogen sulphide to precipitate zinc. Boil the filtrate until all hydrogen sulphide is expelled. The solution contains most of the iron. If the glass contains lead, treat the insoluble lead sulphate with hot, concentrated ammoniacal solution of ammonium acetate. Filter and wash. Fuse the insoluble residue with soda and dissolve in hydrochloric acid. Combine the two solutions containing iron, add hydrogen peroxide and boil. Add ammonia and filter the precipitate formed. Fuse with soda and estimate iron by the potassium iodide procedure.[5]

[1]This Journal, vol. 3, No. 3, p. 56-57 (March, 1922).
[2]This Journal, vol. 3, No. 5, p. 95-97 (May, 1922).
[3]This Journal, vol. 3, No. 5, p. 95-97 (May, 1922).
[4]This Journal, vol. 2, No. 1, p. 13-14 (January, 1921).

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NOTICE OF REMOVAL

The publication office of THE GLASS INDUSTRY has been moved to the

Hudson Terminal Building
50 CHURCH STREET, NEW YORK

The Metric System

Ever since the days of Patrick Henry liberty has been extolled as a nation's greatest possession. Yet to the loss of their liberty, during the dictatorship of Napoleon Bonaparte, do the countries of continental Europe owe many blessings. Among the reforms which were ruthlessly enforced, none has been of greater and more lasting benefit than the introduction of the metric system of weights and measures. This system, which is simplicity itself, and which deserves to be considered as one of the foremost accomplishments of the Gallic genius, is now used by practically every nation in the world except the British and ourselves. Time and again scientific bodies have passed resolutions in favor of its adoption, but little has actually been achieved toward making its use more general. We have discarded the stage coach for the Twentieth Century Limited, but with our present system of weights and measures we are still traveling in the ox-cart. Whatever section of the system now in use is considered, length, area, volume or mass, its obsolescence is so apparent as to border on the ridiculous. No one would seriously propose three different systems to measure time, and yet three systems of weight and as many of measure are being used. We have gills, pints, quarts and gallons, fluid drams, fluid ounces, pecks and bushels. We have fathoms, furlongs, knots, surveyors' chains and engineers' chains; long tons and short tons and so forth.

It is surprising that in days when efficiency is the watchword in every industry, it has been impossible to arouse any widespread support for the adoption of a system which would mean such a great saving of time and energy. Complete apathy is shown by those who would ultimately benefit the most by a general introduction of the system. The National Council of the United States Chamber of Commerce recently passed a resolution rejecting the proposal for a referendum on the metric system. A point which had great influence on the gathering was made by a member of the Connecticut Chamber of Commerce when he stated that the support of the affirmative on this question was largely theoretical, and that only one single supporter from the industrial interests could be found. The inference being, of course, that any change from a chaotic condition to a rational system would be "impractical."

It is conceded that the adoption of the metric system would cause quite a little trouble and confusion in the beginning and would cost gauge manufacturers and many other industries considerable money. However, that it would be injurious to industry as a whole, as is alleged by some of the opponents, cannot be seriously entertained by anyone who has given the subject more than passing thought. Any unbiased student of the question will readily see that the introduction of the metric system would be of distinct benefit. The cost of not adopting the system will in each generation more than exceed the expense and trouble of making the change. American industry may well heed the advice given thirty-eight years ago by Sir William Thompson in a lecture before the Franklin Institute when he said: "You in this country are subjected to the British insularity in weights and measures; you use the foot, inch and yard. I am obliged to use that system, but I apologize to you for doing

so, because it is so inconvenient. I hope all Americans will do everything in their power to introduce the French metrical system. I say this seriously; I do not think any one knows how seriously, when I say that I look upon our English system as a wickedly, brain-destroying piece of bondage under which we suffer. The reason why we continue to use it, is the imaginary difficulty of making a change, and nothing else. But I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform."

Technical Consultation Service

THE GLASS INDUSTRY invites its readers to refer to this department any problems with which they may be confronted pertaining to raw materials, glass technology, laboratory and factory practice. While making no pretensions to the possession of unbounded knowledge or infallibility THE GLASS INDUSTRY is ready to assist its readers to the best of its ability in solving their problems. Readers who can offer better suggestions are invited to submit them.

Answers to all questions will be made by mail as promptly as possible. The sources of all inquiries will be held in strict confidence.

Correction

Relative Cost of Using Lime and Limestone.—In the article under the above title (Question 24, this Journal, Vol. 3, No. 4, p. 80) the following typographical errors should be noted: Near the top of columns A and B, 100 $CaCo_3$ and 56 CaO should be transposed. In the last equation on the right (column B) the fraction should read $\frac{476700}{7500}$ instead of as shown.

Question 27—(From France)—Use of Soda Ash in Window Glass—Flattening Oven Troubles.—I was deeply interested in your editorial of January, 1922, about the comparative cost of soda ash and salt cake in the manufacture of window glass and would like to know what is the American practice concerning the use of soda ash in hand-made window glass fabrication?

What are the proportions of sand, limestone, soda ash, salt cake, carbon, in the batch in order to get the best window glass? Are there some special cares for the melting, the fining, and some different physical properties, viscosities, resulting in difficulties in the hand-working, due to the nature of the glass made of soda ash instead of only salt cake?

I have read in the Technical Consultation Service of your March issue, the question 21 about flattening of window glass. Your answer is right, the best results are obtained with a smoky fire, and till now we are using for this purpose raw producer gas from Siemens gas producers gasifying bituminous coal, but we have a lot of troubles, resulting from the quality of the fuel, the clogging of the mains, the smoke in the building housing the flattening ovens.

We should like to get away from these difficulties and we are anxious to know if some experiments have been successfully made of the use of clean and cold gas from either bituminous coal, or anthracite in order to ascertain the right temperature, and the right atmosphere in the flattening ovens for window glass.

Are there some American window glass plants operating successfully with clean and cold gas for flattening ovens?

I am mailing samples of mechanically drawn window glass under separate cover. Will you kindly tell us

1. Whether the glass is properly annealed.
2. Whether the striae are due to (a) devitrification; (b) variations of refractive index; (c) variations in thickness.
3. Do you think the striae will persist after grinding and polishing?

Answer.—A window glass batch which has been used for many years with complete success in several of the largest factories in the United States is as follows:

Sand	1,000 lbs.
Limestone	350 "
Soda ash	280 "
Salt cake	60 "
Coal	5 "

This batch yields glass of about the following composition:

Silica (SiO_2)	72.15 per cent
Lime (CaO)	14.14 " "
Sodium oxide (Na_2O)	13.71 " "
Total	100.00 " "

The glass nearly always contains about 0.25 of iron oxide and 1.25 alumina, derived from the raw materials and partly (especially the alumina) from the tank blocks, floaters and rings. This of course lowers the percentages of the constituents somewhat. We have found that the ideal composition of a window glass is about as follows:

Silica	71.55 per cent
Iron oxide	0.25 " "
Alumina	1.20 " "
Lime	13.50 " "
Sodium oxide	13.50 " "
Total	100.00 " "

The limestone nearly always contains a certain amount of magnesia which in small quantities may, for all practical purposes, replace lime, weight for weight.

No special difficulties are connected with the manufacture of window glass from soda ash, in fact the practice has a great many advantages. Soda ash glass requires about 25 per cent less fuel than salt cake glass for the chemical combination of the raw materials into glass. When 45 per cent cullet is used the advantage is about 15 per cent in favor of soda ash. Of course, these figures do not apply to the total heat requirements; 90 per cent of the heat necessary to make glass is used for heating the furnace and is lost by radiation, through the stack, etc., and this amount is fixed, whether soda ash or salt cake glass is made.

Soda ash glass also needs less fuel because it can be made at a lower temperature than salt cake glass; it requires less time for melting and attacks the tank blocks less violently, thereby lengthening the life of the tank. Instead of sulphur dioxide, which is distinctly injurious to human and to vegetable life, it yields harmless carbon dioxide.

From whatever standpoint the matter is considered, whether industrial, technical, economical, agricultural or hygienic, one must come to the conclusion that soda ash should have the preference over salt cake. Moreover, at present prices the use of soda ash is less expensive and the finished product has a better color and better physical qualities. This conviction has been reached after many years of practical experience in the manufacture of window glass, during which time both salt cake and soda ash glass were repeatedly made alternately, while conditions and results were carefully studied and compared.

Regarding your question in reference to flattening window glass, we believe that only with cold, clean producer gas, satisfactory results can be obtained in flattening ovens. Raw producer gas invariably contains dust, soot and tar in finely divided condition. These impurities settle on the flattening stones and on the glass and cause trouble. The extra expense of installations for cleaning producer gas and the loss of sensible heat are, of course, factors to be considered. However, in order to obtain the best results we believe that cold clean producer gas is cheaper in the long run.

Regarding the question as to whether the samples of glass you submitted are properly annealed, we shall be glad to refer you to consulting laboratories possessing the necessary instruments for making annealing tests.—J. B. K.

Question 28.—After operating our bottle factory a short time we find it cannot be done at a profit. There is some fault in the construction of our furnace and there may be

other faults in the construction of the plant. We are not experienced glass men and the men we depended on to construct the plant seem to have made a failure of it. We are determined to continue the business, and the purpose of this letter is to get information from you as to whom we ought to get in touch with in regard to the construction of a plant along modern lines.

We also would like to employ a first-class glass man to manage the plant after it is reconstructed.

We first want to establish beyond doubt that we have available raw materials of the proper quality and are enclosing analyses of sand and lime which we can obtain in practically unlimited quantities. We would like to have your opinion as to whether or not first-class glass can be made from these materials.

ANALYSES OF SAND

I

	Natural Condition.	Dry Basis.
Moisture	0.04 per cent	
Silica (SiO_2)	99.72 " "	99.76 per cent
Iron oxide and alumina	0.30 " "	0.30 " "

Lime (CaO) slight trace.
Magnesia, none.

II

	Natural Condition.	Dry Basis.
Moisture	0.02 per cent	
Silica (SiO_2)	99.58 " "	99.60 per cent
Iron oxide and alumina	0.35 " "	0.35 " "

Lime (CaO) trace.
Magnesia, none.

Answer.—Your furnace troubles should be diagnosed by a competent engineer. We have sent you the names of several reliable engineering concerns who specialize in glass melting furnaces and whose announcements may be consulted in our advertising columns.

In regard to the analyses of glass sand, it would be difficult to find a better grade. As a matter of fact, we know of only few sands which are higher in silica, viz.: Berkeley Springs sand from West Virginia and the well-known deposits in Illinois. You can be absolutely sure that whatever trouble you may encounter it cannot be due to the sand.

Sand of this quality can be used in the manufacture of any glass, except of course optical glass or high grade crystal ware, which requires sand which is very low in iron. The iron oxide contents is not given separately in the analysis. It would be well, in the future to insist on a report in which iron oxide and alumina are given separately, since alumina does not affect the color of the glass while iron oxide does.

The analyses of hydrated lime which you have submitted are practically of no value to the glass maker. One analysis gives 3.72 per cent impurities, without stating what these impurities are. It is for the purpose of knowing the composition of a limestone that an analysis is required, and to dismiss the subject by calling a number of compounds "impurities" defeats the object of having an analysis made. No analysis of any material used in glass making is complete when a separate estimation of iron oxide is omitted, and every manufacturer should insist on this most important item.

It should be noted further that one of the analyses yields a total of 102.90, showing careless work.—J. B. K.

Letters to the Editor

Glass Sand on the Western Coast

To the Editor of THE GLASS INDUSTRY:

We note some interesting remarks in the May issue, page 104, regarding "Glass Sand on the Western Coast" in which you state that most of the glass companies are purchasing their supply of Belgian sand from the West Coast Glass Company of this city, and also to the effect that this company has receiving bins at San Pedro for this material as it is unloaded from the steamer.

The correspondent who gave you this information erred in that this company is the only company that has storage bins at San Pedro and is twice as large a consumer of high grade silica sand as any glass bottle factory in Southern California. This company used over 3,000 tons of sand that was imported from Belgium last year and has arranged with the Outer Harbor Dock & Wharf Company to receive this material in bins specially erected for this purpose, from which we draw our supply as consumed.

We note that your correspondent says that our competitors are selling most of the larger glass companies this sand at $5.00 per ton. To the best of our knowledge this sand costs approximately $7.00 per ton by the time wharfage, handling, and freight is paid to Los Angeles, and it is customary for all the local companies to contract for their own supply.

SOUTHERN GLASS COMPANY.

May 12, 1921.
Los Angeles, Cal.

To the Editor of THE GLASS INDUSTRY:

In the marked copy which you sent us, we read with interest what you had to say about the manufacture of silica sand suitable for glass manufacture. At the present time we are manufacturing glass sand for our own use and a high grade white, gritless, plastic clay at our Ione plant. The sand is shipped to our plant at Berkeley, where we manufacture silicate of soda in its various forms.

PHILADELPHIA QUARTZ COMPANY OF CALIFORNIA
By A. W. ELKINTON,
General Manager.

May 11, 1922.
Berkeley, Cal.

Books

THE MANUFACTURE OF OPTICAL GLASS AND OF OPTICAL SYSTEMS.—A WAR TIME PROBLEM.—Ordnance Department Document No. 2037, by Lieut. Col. F. E. Wright, Ordnance Reserve Corps. Size 9½ x 6 inches, 298 pages. Government Printing Office, Washington, D. C.

The author of this book was in charge of production and inspection of optical glass at the plant of the Bausch & Lomb Optical Company from April, 1917 to May, 1918; the army representative on the military optical glass and instrument section of the War Industrial Board from March 25, 1918, until after the Armistice. He was chairman of the army commodity committee on optical glass and instruments and in charge of optical systems in the fire-control section.

This publication is a result of the author's experience in the various capacities in which he served during the war, and forms a complete treatise on the manufacture of optical glass. It is written in a clear style and while no effort is made to avoid highly technical matters, their treatment is so concise and lucid that no difficulty is experienced in following the discussions. The volume contains 94 illustrations and many references to original sources of information.

ZIRCONIUM AND ITS COMPOUNDS, by Francis P. Venable, American Chemical Society Monograph Series. Published by the Chemical Catalog Company, Inc., New York. Size 6 x 9; 173 pages, bound in cloth. Price $2.50.

This is the fifth book of the series of American Chemical Society Monographs. It describes the history and occurrence of zirconium and contains a detailed description of this element and its compounds with other elements, the various acid and basic radicals and with organic compounds. One chapter is devoted to methods of qualitative and quantitative analysis of zirconium and its separation from other elements. To the reviewer it is not clear why only generalities are indulged in, and for definite information one is referred to the literature, which may or may not be available to the reader. The analytical chemistry of zirconium is so limited that many more concrete and usable facts could have been given in the space allotted to this subject. The same can be said of the chapter devoted to the technical applications of zirconium. Refractories, glass and enamels together, do not get as much as a page.

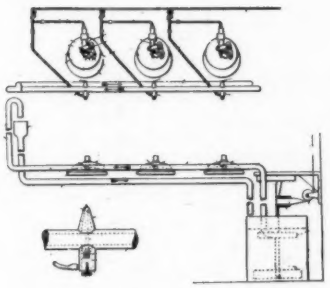
The book contains numerous patents and its bibliography is admirable in its completeness.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Copies of the Patent Specifications mentioned below may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c. each.

Method of and Appliance for Polishing Glass and the Like Substances.—U. S. 1,409,888. March 14, 1922. William Taylor, of Leicester, England.

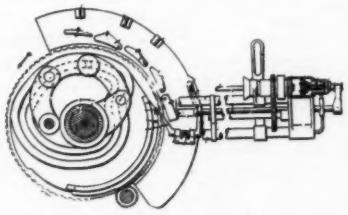


This invention relates to methods of, and means for, polishing glass and the like substances by means of powdered abrasive such as rouge in a liquid vehicle or lubricant, and its object is to provide a method and means whereby, during the process of polishing, the supply of lubricant, or lubricant and abrasive, is effected automatically as required.

This may be done by taking advantage of the varying adhesion, that is, the frictional resistance to relative movement, which takes place between the polishing tool and the work as the polisher becomes dry.

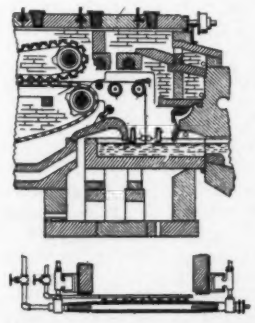
Initial-Puff Mechanism for Glass-Blowing Machines.—U. S. 1,410,857. March 28, 1922. Jacob Weisenberger, of Corning, New York, assignor to Corning Glass Works, of Corning, New York.

In Letters Patent No. 1,124,701, issued on an application of Benjamin D. Chamberlin for "an apparatus for the production of blown glass articles," there is disclosed means whereby an air pump is actuated from time to time to force air into a marvered blank on the end of a glass carrying blow-pipe to expand the same, the actuation of the pump, for the purpose stated, following a movement of the blow-pipe from the marvering position.



The present invention relates to a device designed to be attached to such apparatus, and to actuate the pump previous to the movement of the blow-pipe from marvering position for causing the initial puff.

Method and Apparatus for Drawing Sheet Glass.—U. S. 1,411,079. March 28, 1922. Fernand E. Deulin, of Charleston, West Virginia, assignor to the Libbey-Owens Sheet Glass Company, of Charleston, West Virginia.

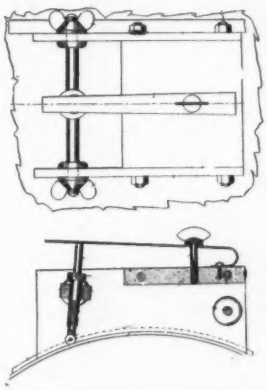


This invention relates to the art of drawing sheet glass, and has for its object to provide a method and apparatus capable of producing a superior quality of drawn glass free from wavelines or corrugations and having a fine unmarred fire-finish or glaze.

The invention consists in drawing the glass vertically, during which period it is permitted to cool to a point where it will not take impressions from the bending roll and hence will not be marred thereby, then bending the glass over the bending roll from a vertical into approximately horizontal position, and, just before it leaves the bending roll, re-heating the sheet while still under drawing tension, whereby the formation of corrugations or waves is either prevented or such corrugations and waves as may have been formed are eliminated.

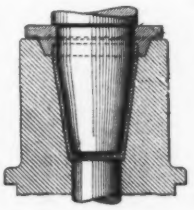
Glass Cutter.—U. S. 1,411,524. April 4, 1922. John R. Scohy, of Okmulgee, Okla.

This invention has for its object to provide a means for readily cutting glass. It particularly has for its object to provide a glass cylinder cutter which may be readily manipulated to sever the glass cylinder into parts. In constructions containing this invention, a means is provided for holding a glass cutter point such as a diamond or wheel in a definite position relative to the surface of the cylinder while the point is being drawn around the cylinder.



The inventor claims that the cutter can be contained in structures of different forms, a practical application being shown in accompanying illustration.

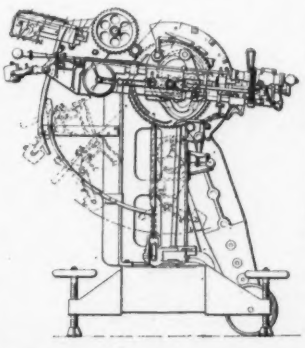
Ring Mold for Glass Presses and the Like.—U. S. 1,412,358. April 11, 1928. Peter Kucera, of South Connellsville, Pennsylvania, assignor to Capstan Glass Company, of South Connellsville, Pennsylvania.



The invention relates broadly to glass machinery and more specially to a ring mold for block molds and the like. The principal object of the invention comprises a ring mold for block molds or the like having a body portion of relatively soft metal with the matrix groove and edge part of hardened compact metal.

The wearing edge of the ring mold comprises condensed metal which is more dense and of greater hardness than the body portion of the ring mold.

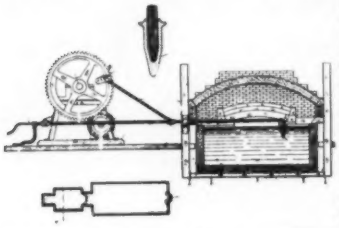
Method and Apparatus for Marvering Glass. U. S. 1,410,803. Mar. 28, 1922. David E. Gray and Frank E. Bardrof, of Corning, N. Y., assignors to Corning Glass Works.



In the device herein described the marverer consists of a roller, mounted on bearings, and revolved by the driving action of the glass when such glass is in contact with the marverer, the marvering roller being mounted for movement toward the axis of the glass under the influence of spring pressure, and being mounted for a tilting action, under spring pressure, in respect to such axis, around a pivot intermediate of the length of the surface to be marvered. The surface of the roller is of conoidal form with its apex when the marvering operation is completed in the prolongation of the axis of the glass, so that the finished blank is a conoid.

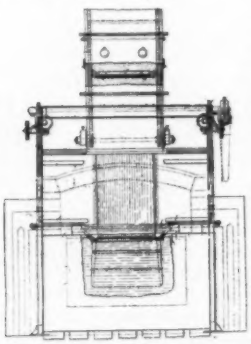
Stirring Molten Glass in Continuous Tank Furnaces. U. S. 1,414,008. Apr. 25, 1922. Wilbur F. Brown, of Charleston, W. Va., assignor to the Libbey-Owens Sheet Glass Company, of Toledo, Ohio.

The device shown in the illustration is particularly designed for use with a continuous tank furnace of the type which supplies a flow of molten glass from which a continuous sheet of glass is drawn, as in the Colburn process, set forth for example in the patent to I. W. Colburn, 1,248,809, granted Dec. 4, 1917. This stirring system is in no wise limited to the above, or any other sheet drawing process, but may be used with any furnace or system, where a continuous supply of glass is melted and flowed to a delivery point.



In a furnace of the above mentioned type, the mixed batch and cullet is fed in at one end of the tank, where it is melted by exposure to intense heat, and slowly flows back through suitable refining and cooling chambers, till it is of the proper temperature and consistency for delivery to the sheet-drawing or other article forming machine as the case may be. Now certain elements of the batch, such as the alkalies, have a lower fusing point than other components, such as lime and silica, and if the temperature of the furnace should fall somewhat below normal, the components will melt unequally and the flow of molten glass will become streaked and of uneven composition. These streaks or flow lines, if left undisturbed, may follow through the entire furnace and be drawn into the sheet produced from the molten glass, causing striae or "lines" in the sheet, which injure the quality of the finished product. It is the purpose of the apparatus about to be described, in connection with the accompanying drawings, to break up these flow lines, and blend and interfuse the uneven striae in the molten glass, so as to furnish an even and homogeneous flow of glass to the drawing point. A stirring finger or thimble of porcelain or pot-clay is carried on a downwardly projecting stirring rod, secured by a suitable elbow to the end of a horizontal supporting rod, which extends through an aperture in one side wall of the furnace. The rods are water-cooled to prevent their destruction by the furnace heat, being preferably formed of inner and outer pipe sections, the water flowing in from a hose connection through the inner pipe, thence back through the outer pipes, and through a flexible connection to the sewer. The finger, when in working position, projects downwardly into the slowly flowing stream of molten glass, and by means of the supporting rod, the finger may be reciprocated back and forth through the flowing glass thus breaking up and dispersing the lines of uneven composition in the glass stream and improving the quality of the product.

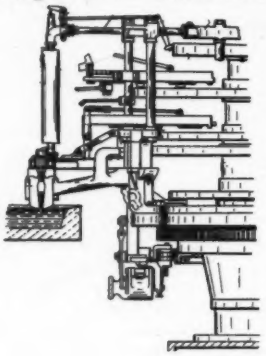
Apparatus for the Manufacture of Glass in Continuous Sheets. U. S. 1,413,238. Apr. 18, 1922. Eugène Rowart, of Auvelais, Belgium.



An object of this invention is to secure means which will be adapted to maintain the whole mass of glass which is contained in the chamber where the glass is taken at a high temperature, surrounding on all sides the apparatus for taking the glass in such a manner that the upper layer of the flow will be maintained at a suitable fluidity.

Another object of this invention is to provide means for protecting the glass sheet in formation against this high temperature and a further object is to provide means for the taking of the glass at a suitable depth into the mass of molten glass, that is to say at the depth where it is in the most favorable state of physical and chemical equilibrium for the drawing operation and without that a modification can occur in the other parts of the molten glass.

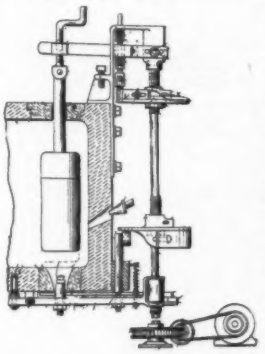
Vacuum Capacity Device for Glass Machines. U. S. 1,413,742. Apr. 25, 1922. Richard La France, of Toledo, Ohio, assignor to the Owens Bottle Company, of Toledo, Ohio.



This invention relates to improvements in glass forming machines and more particularly to machines of the type in which suction is employed for charging the molds with molten glass. The invention is herein shown as applied to a machine of the Owens type in which a series of gathering molds are brought successively over a tank containing molten glass into which the lower ends of the molds are dipped, the air being then exhausted from the molds, causing the glass to enter the molds.

Process and Apparatus for Feeding Glass. U. S. 1,413,757. Apr. 25, 1922. William J. Miller, of Swissvale Borough, Pa.

The object which the inventor claims to have in view is the feeding of molten glass from a tank or other container in proper condition, at proper intervals and in proper quantities to form gathers for glass fabricating mechanism.



The tank or other container is provided with a discharge port for the outward flow of molten glass. Associated with said port is shearing mechanism, which at proper intervals severs the glass protruding from the port to form gathers.

A pushback or stopper mechanism which acts between shearing operations to temporarily interrupt the flow of glass through said port is provided. Said pushback is arranged to enter the outer end of the discharge port after a shearing operation, thus forcing the chilled neck of glass inwardly toward the zone of remelting heat, and the impingement of the pushback against the glass, chilling the surface of the same thereby forming a temporary dam or obstruction of hardened glass. This wall of chilled glass, the pushback having been in the meanwhile removed, holds back the molten glass until melted by the heat when it breaks down permitting the hot glass, to flow down through to form the next gather.

Conveyor for Heated Glassware. U. S. 1,414,212. Apr. 25, 1922. Alexander Samuelson, of Terre Haute, Indiana, assignor to Chapman J. Root, of Terre Haute, Indiana.

The chief object of the invention is to provide a conveyor means which will transport glassware articles, such as bottles from the blow molds to the annealing ovens, and which will not disfigure the base or bottom of said glassware.

The chief feature of the invention consists in roughening the glassware supporting surface of the conveying means to reduce the surface in contact with the glassware, whereby the rapid transfer of heat from the glassware to the conveying means is reduced.

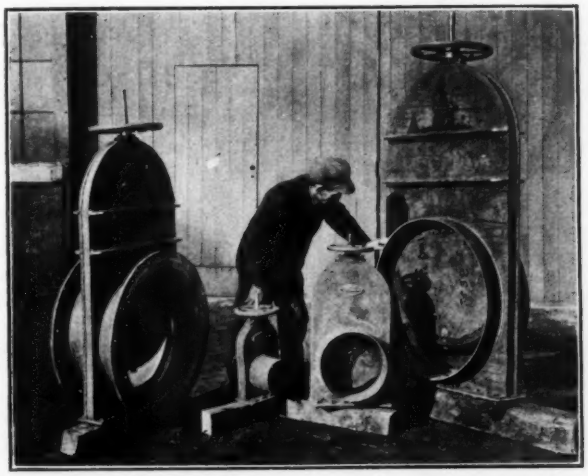
Glass Manufacture.—British Patent Applied For, Jan. 11, 1922. P. T. Freuler, Schwanden, Switzerland. Relates to black glass, with small thermal expansion, used for electric insulation purposes. Natural rock such as schist containing quartz, lime and alumina, is melted and additions of one or more of these substances added until the molten product contains approximately 1 part aluminum oxide, 1.65 parts calcium oxide and more than 3.56 parts of silica, the excess of silica over 3.56 parts being provided in order to convert all other oxides present into silicates. The chemical formula of the finished product is $(SiO_2)_6$, Al_2O_3, $(CaO)_2$ and the melting point about 1,250 C.

Glass Factory Equipment and Supplies

THE GLASS INDUSTRY will be glad to publish descriptions of new and useful devices, machinery and supplies of interest to the glass manufacturing trade. Most of the information printed in this department comes direct from the manufacturers of the products described.

The Steere Blast Gate

Blast gates composed entirely of steel in sizes from 6 inches in diameter up to any required dimensions are made by the Steere Engineering Company, 3162 General Motors Building, Detroit, Mich. Two discs of steel plate rigidly welded to spacing blocks are actuated by a rising stem with Acme thread, operated by a large hand wheel. The surfaces



THE STEERE BLAST GATE

against which the discs seat are machined and the manufacturers state that when the gate is closed, it is as tight as it is physically possible to make it without wedging mechanism. The yoke is of cast steel with brass bushing. The body is of welded steel, the domes on all sizes above 14-in. are reinforced as shown in the illustration. By removing the bottom plate, the stem and discs can be taken out and the gate completely dismantled for cleaning without removing it from the line.

Cementing Glass Bulbs to Metal Bases

The General Bakelite Company, 8 West 40th street, New York, manufacture Bakelite Cement "27-D," which they state is being successfully used for lamp basing work in a number of the largest lamp works in the country. It is prepared in powder form all ready for use, with the exception of the addition of the solvent. No marble dust or other filling ingredients should be added.

The solvent used is denatured alcohol in the proportion of approximately 6 per cent, or one ounce to one pound of cement. Ordinary paint mixers or kneading mills are used for mixing the material.

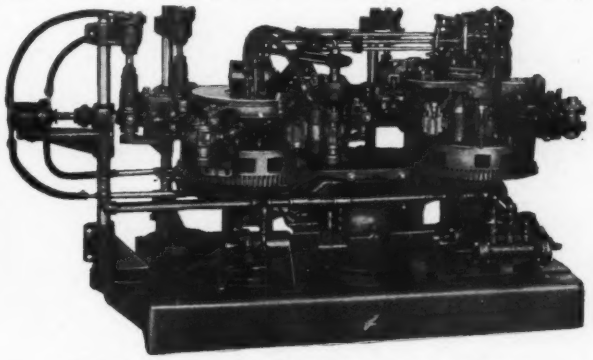
After the lamp bases have been filled with cement they are allowed to air dry for about twenty-four hours before using. Filled bases may be used satisfactorily up to a week or ten days after filling, but if allowed to stand for a longer period the cement is liable to get too hard and crack the lamps during the basing operation.

The bases are attached to the lamps in the standard type basing machines, but the temperature should be increased to 200° C. on the socket ring of the machine, so as to give an actual temperature on the base of 165° C. The period of rotation for the standard No. 102 base should be from 2¼ to 2½ minutes.

Basing machines especially designed for this particular application are necessary in order to insure satisfactory results. It is doubtful whether the cement would work satisfactorily in connection with the attaching of glass to metals or vice versa, except under conditions somewhat similar to those in the incandescent lamp industry. For instance, it is very doubtful whether a flat piece of brass could be attached to a flat piece of glass by means of this cement. On the other hand it is quite likely that it would work satisfactorily in attaching the metal stopper on perfume bottles, or for other forms in which it is desired to cement a metal ring to a cylindrical piece of glass.

New Lynch Automatic Bottle Machine

The new model Lynch automatic bottle blowing machine tested out in production some weeks ago at the plant of Turner Brothers Company, Terre Haute, Ind., is shown herewith. It is the latest product of the Lynch Glass Machinery



NEW MODEL LYNCH BOTTLE BLOWING MACHINE

Company, Anderson, Ind., James W. Lynch, president of the company states that from the beginning the machine surpassed all expectations by promptly turning out prescription bottles of half-ounce size at the rate of thirty-two per minute, a mechanical feeding device, of course, being used. The machine successfully handles sizes ranging from a half to two and a half ounces.

Business Publications

Standard Chemicals for All Industries.—A 16-page booklet issued by John C. Wiarda & Company, Inc., Brooklyn, N. Y., in which is listed the chemicals in which the Company specializes. Those of particular interest to the glass trade include hydrofluoric, boric and other acids, antimony oxide; white arsenic, barium carbonate and hydrate, bone ash, borax, kaolin and china clay, cobalt oxide, red and black copper oxide, cryolite, feldspar, fluorspar, red lead, litharge, manganese oxide, nickel oxide, potassium carbonate and nitrate, powder blue, soda ash, sodium nitrate, sodium silico fluoride, salt cake sulphur, talc, uranium oxide, zinc oxide, zirconium oxide.

The booklet contains an announcement by Howard B. Bishop, president of the Company, offering the co-operation of its technical service department for helping to solve its customers' chemical problems.

D F C Oil Burners.—The Denver Fire Clay Company, Denver, Col. Bulletin 301. A 32-page catalog devoted to a discussion of the combustion of fuel oil, illustrations of D F C Burner applications, descriptions of the company's various types of oil burners, and other products.

A list of importers and dealers in glass and glassware in Brazil may be obtained from the United States Bureau of Foreign and Domestic Commerce, Washington, D. C., by referring to file LA-12048.

Industrial News

Laboratory Assistants Wanted

Open competitive examinations for laboratory assistant, senior grade, and for laboratory assistant, junior grade, and laboratory senior aid, are to be held by the United States Civil Service Commission on June 7 and 8, and July 19 and 20, 1922, at various points throughout the country. Vacancies in the Bureau of Standards or elsewhere in positions requiring similar qualifications will be filled from these examinations, at salaries ranging from $1,200 to $1,380 a year for senior grade assistants, $1,000 a year for junior grade, and $900 a year for senior aids. Appointees whose services prove satisfactory may be allowed the bonus granted by Congress of $20 a month.

Competitors in the examination for laboratory assistant, senior grade, will be rated on the following subjects:

	Weights
1. General chemistry and elementary physics	20
2. Mathematics (including differential calculus)	20
3. Optional subject	30
4. Education, training and experience	30
Total	100

The optional subjects are as follows:

1. Advanced general physics.
2. Electrical engineering.
3. Civil and mechanical engineering.
4. Chemical engineering.
5. Paper technology.
6. Textile technology.
7. Ceramics.
8. Physical metallurgy.
9. Physics and chemistry.

Applications for qualification under optional subject 7, "Ceramics" must have completed a two years' course in ceramic engineering.

Competitors in the examination for laboratory assistant, junior grade, and for senior aid, will be rated on the following subjects.

	Weights
1. Physics and chemistry	20
2. Mathematics (through trigonometry)	20
3. Mechanical drawing	10
4. Education and experience	50
Total	100

Applicants should at once apply for Form 1312, stating the title of the examination desired, to the Civil Service Commission, Washington, D. C.

Examinations for junior engineer, in which ceramic engineering will be one of the optional subjects, will be held July 5 and August 23, 1922, to fill vacancies paying from $1,200 to $1,500 a year.

First National Merchandise Fair

A number of the most prominent and successful merchants from the principal commercial centers of the country have co-operated with various national trade associations to establish in New York City a great merchandise fair, similar to those famous fairs which have been so successful at important European centers where they have become annual institutions, visited by merchants and buyers from all over the world.

The first National Merchandise Fair to be held in this country will take place at the Grand Central Palace, from August 7 to 25 inclusive, a season of the year which always finds many buyers in New York. It will not be open to the general public, only to merchants and buyers, and it is expected that there will be a large foreign attendance as well as many visitors from all parts of America. Four floors of the immense Grand Central Palace will be utilized and goods of every kind sold in department stores will be exhibited. The Fair offers a novel opportunity for manufacturers of glassware of many different kinds to display their products before an audience of buyers under conditions favorable for the obtaining of orders.

Col. Michael Friedsam, of B. Altman & Company, is chairman of the general executive committee. The headquarters of the National Merchandise Fair are in the Fifth Avenue building, corner of Fifth avenue and 23rd street, New York, a building which houses the New York representatives of many glass manufacturers.

Spring Meeting, Glass Container Association

At the meeting of the Glass Container Association held at Atlantic City, April 27, 28 and 29, in conjunction with the National Bottle Manufacturers' meeting all of the officers were re-elected to serve another year. C. J. Root is president; I. R. Stewart, 1st vice-president; E. B. Ball, 2nd vice-president; H. J. Booth, secretary; R. E. Walker, treasurer; I. G. Jennings, business manager; Dr. A. W. Bitting, research director and J. T. Hendricks, traffic director.

Philip I. Hueisler, president of the Maryland Glass Corporation, was elected a director in place of C. O. Stewart, of the Kearns-Gorsuch Bottle Company.

At the several meetings, in addition to the regular business routine, there were interesting remarks on subjects of importance to the trade, by the president, C. J. Root; Dr. A. W. Bitting, director of research; J. T. Hendricks, traffic director; W. H. Matson, chairman Crown Cap Division; Judge I. G. Jennings, business director, and others.

At the Bottle Manufacturers' meetings committee reports were made, trade statistics and charts presented, business conditions and wage questions discussed. Several talks were given by representatives of the canners', preservers', druggists' and proprietary associations.

Mexico Encourages Glass Research . .

Professor Javier Vertiz of the Department of Glass Research and Technology, University of Mexico, Mexico, D. F., visited Toledo, O., about the middle of May and spent several days as a guest of the O'Neill Machine Company, one of whose No. 25 machines together with a No. 10 press, is in use in the Department's laboratory. Professor Vertiz reports that the University is doing everything that such an institution can do for the improvement of the glass industry in Mexico and that the government has made liberal appropriations for the support of the laboratory and encourages the work in every respect, with the result that excellent progress is being made.

English Trip May Be Postponed

Only a few members of the American Ceramic Society having up to May 31 signed up for the proposed visit to England this summer as guests of the Society of Glass Technology, there is a possibility that the trip may be postponed. It is felt that the party should include a minimum of 25 members. A meeting of the committee in charge of arrangements, of which Dr. E. Ward Tillotson is chairman, will be held shortly to decide on the action to be taken.

Miscellaneous Items

Australian Glass Manufacturers Co., Ltd.—A correspondent in Australia sends a copy of an article from the *Sydney Bulletin*, from which the following is taken: "This company at the close of 1915 amalgamated the Melbourne Glass Bottle Works Pty., Ltd. (which had been started in 1872) with the Waterloo Glass Bottle Works, Ltd., and Vance and Ross, both of Sydney. It established works in all States except Westralia, and had a remarkably successful career after modern methods had been introduced. Having averaged about £22,000 p. a. profit on a paid capital of £276,000 up to March, 1919, the disclosed profits moved to £51,106 for 1920, and £65,524 for 1921, capital having advanced to £442,489 at the latter date. To finance further extensions £175,000 of 9 per cent cumulative preferred shares were issued and snapped up last year. In 1919 W. J. Smith, who had been responsible for the amalgamation, but had withdrawn from the management of the company, established in Sydney the Zetland Glass Bottle

Works, Ltd., backed by powerful interests. That company has had a meteoric rise and has bagged some huge long-distance contracts. With modern glass-blowing methods it also has made luscious profits, and to cope with its contracts within two years increased nominal capital from £15,000 to £250,000. The company has at present 155,233 £1 shares fully paid and 65,431 more paid to 5s. These two big competitors, who have practically controlled the bottle industry in the commonwealth and the bottle market in Maoriland, have decided that it would be of mutual advantage to get together. So it is proposed to form a new company, the Australian Glass Manufacturers Co., Ltd., with a nominal capital of two million pounds, in which each of the present companies will get share for share the old A. G. M., first capitalizing £110,000 of reserves which it has accumulated in its short life. Paid capital will be approximately a million. W. J. Smith will be managing director of the concern. The market is not likely to see much of the scrip; the concern is partially co-operative; practically all the big bottle-users are substantial holders and the other shares (apart from the preferreds, of course), are not widely distributed. The A. G. M. proposes also to manufacture sheet glass sufficient for the commonwealth's requirements. None has so far been produced locally."

Glass Men Active in Obtaining Rate Reduction.—The Interstate Commerce Commission on May 24 announced that effective July 1 a reduction amounting to 10 per cent of the present freight rates will be made in presenting to the Interstate Commerce Commission the claims of the container manufacturers for a reduction in freight rates on bottles and other containers, caps and closures, bottle-making machinery, bottling machines, shipping containers, silica sand, soda ash and lime, J. T. Hendricks, traffic director of the Glass Container Association, gave the following information: Sixty-eight of the 116 members of the association are manufacturers of glass bottles and other containers, all the heavy tonnage producers being included. These members complain that the existing high level of freight rates is more and more restricting the territory in which their products can be marketed and is thus tending to localize the industry, a situation which is depriving many of the carriers of long haul traffic which they would enjoy under the normal adjustment of freight rates.

Mr. Hendricks maintained that the heavy tonnage developed by the members of the association entitled the industry to a reduction in rates even if the commission should decide against a general rate reduction and to substantiate his claim that the products of the glass bottle industry are in need of consideration at least equal to that given any other industry, he submitted the following members' tonnage data:

> September 1, 1919 to September 1, 1920, approximately 9,574,105 tons inbound, and 3,829,642 tons outbound. This dropped to approximately 6,610,682 tons inbound and 2,644,273 tons outbound, September 1, 1920 to September 1, 1921.

At a rate hearing before the Interstate Commerce Commission, J. M. Bellville, general traffic manager of the Pittsburgh Plate Glass Company, said:

> "Reductions on raw materials would do us more good than reductions on finished glass. Sixty per cent of a batch of glass is sand. I can see no reason for allowing a lower rate on building than on glass sand, especially when, as is the fact, the railroads obtain two hauls on glass sand. It comes in as a raw material and goes out as a finished product. Building sand moves only once."

Standardization of Finishes for Glass and Closures.—Steps taken by the committee in charge of co-operative standardization work for the glass manufacturers and cap makers towards reducing the multiplicity of sizes, finishes, and closures, which have always been source of annoyance and loss, are described in the May number of *The Glass Container*. The accomplishments so far as follows:

1. Standardization of the continuous screw thread glass finish of the usual sizes and gauges for the same. Prints No. 4190 and No. 4191.

2. Screw thread caps with rolled edge to correspond to the glass finish and diameter gauges. Prints Nos. 4673, 4674, and 4753.

Straight side jar finish for all closures gripping on the sides in sealing. G. C. A. No. 1 and No. 1A. Prints Nos. 4732 and 4733.

3. Test ring for the straight side finish. Print No. 4734.

4. Tumbler finish. Print No. 4828.

5. Gauge for tumbler finish. Print No. 4829.

6. Combination crown and screw thread glass finish for narrow mouth glassware, 26½ and 36 mm. bottles (ketchup and chili sauce). Print No. 1234.

7. The acceptance of the No. 1 crown finish for beverage bottles as standard. Prints from the Crown Cork & Seal Company.

8. The acceptance of the Kork and Seal specifications as applying to that trade style. Prints from the Williams Sealing Corporation, Decatur, Ill.

All prints are available from the Research Laboratories, Glass Container Association.

Favors Modified Prohibition Laws.—At the annual stockholders' meeting of The Owens Bottle Company, April 12, 1922, President M. J. Owens, made the statement that the company and in particular, its subsidiary companies, the American Bottle Company, the Graham Glass Companies, and The Charles Boldt Glass Company, had suffered large reductions in earnings under the present enforcement of the Volstead Act; and urged the adoption of a resolution favoring a modification of the prohibition laws which will permit the sale of light wines and beers under proper Governmental regulation, with a substantial tax to be levied upon such sale.

In closing the meeting Mr. Owens made the following remarks: "Before we adjourn, I ask you to give serious consideration to the grave economic condition brought about by the sweeping character of this law. If light wine and beer can be brought back, we honestly believe it will be for the welfare of the nation. But if you would ask me, although it means 3,000,000 gross of bottles a year to this company—if you would ask me to bring back conditions as we had them before, that is, whiskey and the saloon, I would vote against it. When we advocate and ask everyone to join with us in bringing about a restoration of our former business conditions, we ask it in all sincerity and in all honesty; and we do not ask anybody to lay aside his convictions if he does not agree with us."

Changes in Fibre Shipping Container Rules.—In Bulletin No. 6, Traffic Department, Glass Container Association, issued April 28, J. T. Hendricks, director of traffic, states that no changes will be made in rules or requirements except in connection with liners in packages. It is expected that the use of liners will be required on top, bottom and sides of the package of glassware or fragile articles weighing less than thirty pounds, the same as for similar shipments in packages weighing in excess of thirty pounds, exception being made in the case of fruit jars of specifications as follows, on which no liners will be required in packages of less than thirty pounds:

"Jars, N. O. I. B. N.: Note.—Fruit jars, with openings not less than 2¼ inches in diameter, will be accepted without liners and with shoulder-high partitions in corrugated strawboard boxes when gross weight is not in excess of 30 pounds each, except when jars having glass top with metal spring or wire fasteners over top, full size partitions must be used."

It is expected that the rule as changed will be published in Consolidated Classification No. 3, which becomes effective about July 1st, and in all probability provision will be made postponing the effective date of the new parts of the rule to January 1, 1923.

Five Research Fellowships in mining, metallurgy and ceramics, have been arranged for at the College of Mines, University of Washington, in co-operation with the Northwest Experiment Station of the United States Bureau of Mines. The fellowships are open to graduates of universities and technical schools. The value of each is $780 for the year beginning July 1. The subject chosen for the ceramic fellowship for the year 1922-1923 is the Survey and Testing of Ceramic Resources of the Northwest. The investigation is to consist principally of laboratory work.

The Mid-summer Convention of the National Council of Lighting Fixture Manufacturers will be held in Cleveland, O., on June 28 and 29. It is understood that two of the subjects to be taken up at the coming convention are the introduction of a uniform system of cost-accounting among member-firms and the revision of the Council's bylaws. The question of

selecting a permanent location for the Annual Fixture Market will also be discussed.

A. S. T. M. Annual Meeting.—The twenty-fifth annual meeting of the American Society for Testing Materials will be held at Chalfonte-Haddon Hall, Atlantic City, N. J., during the week of June 26, 1922.

The Eighth National Exposition of Chemical Industries will be held at Grand Central Palace, New York, during the week of September 11, 1922. Manager Charles F. Roth reports that three full floors and part of the fourth have already been taken for the occasion and that 350 exhibitors have already contracted for space. A special section will be devoted to fuel economy, and another to shipping containers. Exhibits of glass and ceramics are being arranged for.

Standard Working Hours as reported by glass factories in New York State to the State Industrial Commissioner were found to be as follows: Of 2,583 men employed by the 10 factories reporting, 6.6 per cent worked 44 hours per week or less; 37.6 per cent, 45 to 48 hours; 4.5 per cent, 49 to 51 hours; 47.9 per cent, 52 to 54 hours; 3.4 per cent, over 54 hours. Of 286 women, 6.6 per cent worked 45 to 48 hours; 93.4 per cent worked 52 to 54 hours.

The annual convention of the National Lime Association will be held June 14-16 at the Hotel Statler, Cleveland, Ohio. The activities of this convention will deal with the technology of, and the industrial problems of manufacturing and marketing lime.

Machinery Prices Lower.—A decrease of about 10 per cent in prices of all types of automatic glass working machinery manufactured by them was put into effect May 1, by the Miller Machine and Mold Works, 705-719 Ann street, Columbus, O.

Standardizing Window Sash.—A movement has been started towards standardizing sash and window openings. A representative of the Bureau of Standards has been obtaining data on the subject—*Technical News Bulletin*, No. 61, May 10, 1922.

Car Surplus.—The serviceable surplus of freight cars for the week ended May 15, 1922, was 343,689, a decrease of 9,550 compared with the week ending May 8th.

Personal News

Julius Holl, advertising manager, Link-Belt Company, Chicago, Ill., whose material-handling and storing equipment is in use in prominent glass factories, was elected president of the recently organized Engineering Advertisers' Association, Chicago; and **H. N. Baum,** advertising manager, Celite Products Company, whose sil-o-cel insulating brick are well known to the trade, was elected treasurer. The object of the association is the study and betterment of advertising methods and conditions affecting the manufacturers of engineering equipment and supplies, and the advancement of the advertisers' interests in the field of publicity.

Deaths

Ernest Solvay, one of Belgium's most distinguished and wealthiest citizens, inventor of the Solvay process for the manufacture of soda, died suddenly at Brussels on May 26 at the age of eighty-four. Mr. Solvay was the son of a salt refiner of modest means. His invention was threatened at the start with commercial failure, and only the perseverance and energy of the inventor brought it through to success. The first patents were taken out in 1861. The process revolutionized the soda industry. Today a very large percentage of all soda ash used in making glass and in other industries is manufactured by the Solvay process.

Franz J. Denk.—With deep regret the many friends of Franz J. Denk, the well-known Pittsburgh fuel and furnace engineer, learned of his untimely death on May 18, at his home in Crafton, Pa. Mr. Denk was but 48 years old. He was a man of advanced views on technical subjects and was widely recognized as an authority on artificial fuel gas and its use in the glass and steel industries. He was an occasional contributor to the trade and technical press, the first portion of his last paper, only recently completed, appearing on another page of this issue.

Verified News of Trade Activities

The **Weston Glass Company,** Weston, W. Va., manufacturers of blown tumblers, has increased its capital from $50,000 to $75,000.

The **Thatcher Manufacturing Company,** Elmira, N. Y., started operations at its Clarksburg, W. Va., plant on May 31 and will run it full time during the present fire.

The **United Mould Company in Receiver's Hands.**—Harold J. Kehoe, 1018 Nicholas building, Toledo, Ohio, has been appointed receiver for the United Mould Company, Toledo, Ohio.

The Paden City Glass Company, Paden City, W. Va., has increased its capital stock from $100,000 to $150,000 and is erecting an addition to its present plant to be used as a cutting-shop, etching and decorating room.

The Capitol City Glass Company, Hartford, Conn., is erecting a 40 by 150 ft. addition to its plant, which when completed will give them a 4-story mill construction building in addition to the present 5-story building.

The **Old Dominion Glass Company,** Alexandria, Va., has completed repairs to its plant which was recently destroyed by fire and has installed new equipment. The plant, the company reports, is now running full capacity.

The **H. C. Fry Glass Company,** Rochester, Pa., verify the report that the recent $600,000 bond issue of the company which was offered at the Peoples Savings & Trust Company, Pittsburgh, Pa., was oversubscribed on the first day.

Glass Companies Resume Operation—The Fostoria Glass Works, Wheeling, W. Va., has resumed operations at its plant after being idle for ten days due to a labor dispute and the **T. C. Wheaton Company,** Millville, N. J., has resumed operations at its North Millville plant.

The Licking Window Glass Company, Utica, O., has had men and teams at work cleaning up the wreckage from the recent fire at its plant, but according to W. Harry McCann, president, nothing had been decided up to May 15, in regard to rebuilding the factory.

The Corning Glass Works is constructing at its main plant, Corning, N. Y., an additional continuous melting furnace to replace one of the older pot furnaces. The new tank furnace will be used in the production of bulbs for incandescent lamps and it is expected that it will be in operation about the first of August.

The **Overbrook Glass Bottle Company,** Jeannette, Pa., has been granted a Pennsylvania charter and has been capitalized at $50,000. The company will manufacture hand and machine ware of all descriptions and it is expected that its plant will be completed and in operation early in August. John H. Stark is president.

Eastman & Company have moved their offices from 63 E. Adams street, Chicago, Ill., to 1252 Monadnock Block, where they have increased facilities for the planning and execution of industrial and technical advertising in trade and technical publications. D. T. Eastman, formerly advertising manager of the Eagle-Picher Lead Company, is head of the company.

An unconfirmed news dispatch says that **A. R. Grant** and **W. D. Bennett** are interested in the establishment of a plant at Portland, Ore., for the manufacture of glass containers. It is reported that the new concern will lease the plant of the Northwestern Steel Company in South Portland, and install modern machinery. It is proposed to obtain sand from Belgium in ballast cargoes at a low cost, while Northwest sand would also be available.

Edward H. Hansen, formerly president of Hansen, Sommer & Maca, Inc., Chicago, Ill., has severed his connections with that company and is now president and general manager of his own company, the **Edw. H. Hansen Machine Company,** with headquarters at 4518-4522 Lexington street, Chicago, Ill. The new company will manufacture glass machinery for beveling and polishing and also will carry in stock accessories such as abrasive materials, polishing wheels, belting, motors, etc.

The **Bonita Art Glass Company,** Wheeling, W. Va., at a recent meeting of the board of directors, declared a dividend of 2½ per cent, both on the preferred and common stock, to stockholders on record, December 31, 1921. Otto Jaeger, secretary and general manager, made a report showing a steady increase of business over last year, and recommended that a new 70 foot lehr be built.

The **Maryland Glass Sand Company,** Hagerstown, Md., has increased its capital stock from $75,000 to $150,000 and has purchased the property and plant of the Round Top Glass Sand Company, Round Top, Md. Improvements and additions have already been made to the Maryland company's plant but it is expected that within the next year the company will further develop and enlarge both plants. The plant is operating on full time.

A. B. Knight, Fairmont, W. Va., whose standard and special machinery for etching, glazing, cracking-off, grinding and other operations are widely known, was on May 10 burned out of the new factory into which he had only recently moved. The building was virtually fireproof except the roof, which unfortunately became ignited from a garage next door. The work of rebuilding was begun at once and pending the completion of the repairs Mr. Knight will take care of all his customers' requirements at his old factory.

The **Central Glass Works,** Wheeling, W. Va., has been advised by S. H. Ingberg, inspector from the Bureau of Standards, Washington, D. C., that all danger of fire from the cinder pit which has been burning beneath the plant for over a year is passed and that the factory is now perfectly safe. The Central company state that $50,000 has been spent for fighting the cinder fire and for the construction of mammoth pillars under the building. Improvements which were recently started at the plant are being continued.

The Automatic Machinery Company, Terre Haute, Ind., through W. H. Johnson, treasurer and general manager, and Mr. Frisz, eastern sales manager, announce the closing of a contract for a second installation of automatic conveyors and lehr feeders at the Atlas factory of Hazel-Atlas Glass Company, Washington, Pa. The first installation went into operation on December 27, 1921. W. H. McFarling reports for the company that the prospects for the future are exceedingly bright, both in the domestic and foreign fields.

Inquiries Received

For further information address THE GLASS INDUSTRY, 50 *Church Street, New York.*

73.—(From Brazil) Please give us the names of manufacturers of machinery for making general glassware.

74.—Please refer us to concerns manufacturing machinery for grinding and polishing glass bars and for tapering them; also machinery used in making glass table tops and shelves.

75.—Please tell us what concerns produce storage battery jars made of glass.

American Window Glass Machine Report

In his statement to the stockholders of the American Window Glass Machine Company at the annual meeting, May 2, President Munro congratulated them on the fact that the company had been able to pay the regular 7 per cent dividend on the preferred stock and 6 per cent on the common, during a period in which many corporations in all lines of manufacturing were obliged to suspend dividend payments altogether. The Company's earnings had been sufficient to take care of the dividends, in spite of a reduction of about 21 per cent in the price of window glass in April, 1921, and another of about 23 per cent in January, 1922. The ability to keep up regular dividends was due solely to plant improvements at practically all factories and increased efficiency of the organization.

Mr. Munro said the directors felt that the most trying period that American industries will ever experience had been safely passed, and predicted much better conditions in the future.

It was recommended that the fiscal year be changed to expire shortly after the close of the fiscal year of the American Window Glass Company which expires August 31. All of the directors, whose terms expired this year, were re-elected. The sum of $3,567,798 was charged off to cover expiration of patents, and it was stated that such amounts as from time to time may be charged off for this purpose would be added to the value of the common stock of the American Window Glass Company held by the American Window Glass Machine Company.

The balance sheet on March 31, 1922, follows:

ASSETS

Patent Rights in United States		$3,431,201.43
Investments:		
129,992 Shares Common Stock American Window Glass Co.		16,566,998.57
United States Liberty Loan Bonds		105,300.00
Cash		30,027.51
		$20,133,527.51

LIABILITIES

Capital Stock:			
7% Cumulative Preferred Stock Outstanding.	$6,999,600.00		
Common Capital Stock Outstanding	12,998,600.00		$19,998,200.00
Surplus:			
As at April 1, 1921	$115,034.27		
Profit for year ending March 31, 1922 (cash basis)	1,290,156.24	$1,405,190.51	
Deduct:			
Dividends Paid—			
Preferred Capital Stock	$489,965.00		
Common Capital Stock	779,898.00	1,269,863.00	135,327.51
			$20,133,527.51

RECEIPTS AND DISBURSEMENTS

April 1, 1921, to March 31, 1922

Receipts—		
Royalties	$1,292.040.14	
Dividends on American Window Glass Company—Common Stock	162,490.00	
Other Income	5,168.31	$1,459,698.45
Disbursements:		
General Expenses and Salaries	$31,582.46	
Taxes	137,959.75	169,542.21
Profit for Year Ended March 31, 1922 (cash basis)		$1,290,156.24

Stock Quotations

(Reported by Moore, Leonard & Lynch, Frick Building, Pittsburgh, Pa.)

PITTSBURGH STOCK EXCHANGE, May 26, 1922

	Bid	Asked	Last
American Window Glass Machine com.	81¾	85	82½
American Window Glass Machine, pfd.	89½	90	..
American Window Glass Preferred	..	105	103
Pittsburgh Plate Glass	159	161	160
U. S. Glass	53½	54¼	54

A strong and active market has been witnessed for all the Pittsburgh glass issues, with Pittsburgh Plate Glass leading the list. Improved conditions are being felt throughout the glass industry and operations are running at a rate that indicates substantial earning ability for the leading glass producing concerns.

WHEELING STOCK EXCHANGE, May 26, 1922

	Bid	Asked	Last
Hazel Atlas	168½	169½	168
Imperial Glass	86	95	100
Fostoria Glass	118	120	117
Central Glass	100	145	145

Glass shares on the Wheeling Stock Exchange have been quiet the past month with the single exception of Hazel-Atlas Glass which registered a very substantial advance of nearly 20 points. Semi-official reports indicate that the Company is enjoying unusual trade with April sales of around $2,000,000 reported. Late reports show that loss from frost throughout the country was comparatively light and activity in the fruit jar trade is still very marked. Central Glass stockholders have subscribed for $100,000 additional stock at par. Fostoria is firm. Imperial paid a belated cash dividend of 1¼% the first of the month.

TOLEDO STOCK EXCHANGE May 26, 1922

	Bid	Asked	Last
Owens Bottle Machine common	36½	37	36⅞
Owens Bottle Machine preferred	..	102	101½
Libbey Owens Sheet Glass common	135	145	...
Libbey Owens Sheet Glass preferred	100	...	100

Market strong and active with substantial activity noted in the Libbey Owens issues—both the preferred and common showing unusual strength in an active market.

Current Prices of Glass-Making Materials

From quotations furnished by various manufacturers and dealers

May 29, 1922

	Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)..lb.	.05½	.06½
Aluminum oxide (Al_2O_3).....lb.	..	..
Antimony oxide (Sb_2O_3).....lb.	.08	.08
Arsenic trioxide (dense white, 99% (As_2O_3).....lb.	.07–.07½	
Barium carbonate ($BaCO_3$)....ton	65.00	70.00
Barium hydrate ($Ba(OH)_2$)....lb.		
Bone ash .....lb.	.05½	.06½
Borax ($Na_2B_4O_7\,10H_2O$) .....lb.	.05¼–.05½	.05½–.06
Borax, fused, any mesh ($Na_2B_4O_7$) .....lb.	.19	.20
Boric acid, fused (B_2O_3).....lb.	.35	.35
Cadmium Sulphide, red (CdS)..lb.		1.60
Cadmium Sulphide, orange.....lb.		1.80
Cadmium Sulphide, yellow (CdS) .....lb.		1.80
Cobalt oxide, in bbls. (Co_2O_3)...lb.		2.00
Cobalt oxide, in 10 lb. tins (Co_2O_3) .....lb		2.10
Copper oxide, red.....lb.		.17 –.20
Copper oxide, black (CuO).....lb.	.23	.26
Copper oxide, black prep'd (CuO) .....lb.		.30
Cryolite (Na_3AlF_6) .....lb.		.09½
Feldspar, 100 mesh.....ton	15.00	
Fluorspar, powdered white, 90% (CaF_2) .....ton	35.00	
Fluorspar, powdered white, 90% (CaF_2) .....ton	33.00	38.00
Hydrofluoric acid .....lb.		
Kaolin .....ton	17.00	25.00

	Carlots	Less Carlots
Lead oxide (red lead) (Pb_3O_4)..lb.	.08¾	.09
Litharge (PbO) .....lb.	.08¼	.08½
Lime—		
Hydrated (in 50 lb. paper sacks) ($Ca(OH)_2$) .....ton	10.50	
Burnt, ground, in bulk (CaO).ton	7.25	
Burnt, ground, in paper sacks.ton	9.25	
Burnt, ground in 280 lb. bbls. per bbl.	2.00	2.05
Manganese 85% (MnO_2).....lb.	.04½	.05 –.06½
Nickel oxide, black (Ni_2O_3)....lb.	.45	.50
Nickel monoxide, green (NiO)..lb.	.50	.55
Potassium carbonate—		
Calcined 90% (K_2CO_3).....lb.	.06	.07
Hydrated 90% (KOH) .....lb.	.06½	.08
Potassium nitrate (KNO_3).....lb.	07½	.07¾
Powdered blue .....lb.		.24 –.26
Powdered blue (std. formula)..lb.		.38
Salt cake, glassmakers, f. o. b. works (Na_2SO_4) .....ton	21.00	28.00–30.00
Selenium (Se) .....lb.		1.95 –2.25
Soda ash, 58% dense, 48% basis Bulk (Na_2CO_3) .....100 lb.	1.22½–1.27½	1.32½–1.37½
Bulk, on contract (Na_2CO_3) 100 lb.	1.17½	
Sodium nitrate, refined ($NaNO_3$).lb.	.04½	.04¾
Sodium selenite (Na_2SeO_3).....lb.		2.35 –3.00
Sodium Fluosilicate (Na_2SiF_6)...lb.		
Sulphur (flowers) (S)—in bbls per 100 lb.	3.35	3.65 –3.90
Sulphur (flowers) Bags per 100 lb.	3.00	3.30 –3.55
Sulphur (flour, heavy), (S) in bbls. per 100 lb.	2.50	2.80 –3.05
Uranium oxide—100 lb. lots (UO_3) .....lb.	2.10	2.25
Zinc oxide (ZnO) .....lb.	.08	.09 –11¼

Monthly Summary of United States Foreign Commerce in Glass

Corrected to April 25, 1922

IMPORTS

	March				Eight-Months Ending March			
	1921		1922		1921		1922	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Glass and glassware:								
Bottles, vials, carboys, etc., plain, empty or filled .....lbs. dut.	579,386	$28,186	514,167	$19,917	6,577,357	$292,543	6,573,858	$264,637
Bottles, decanters, and other glassware, cut or ornamented .....dut.	.....	108,269	.....	149,244	.....	1,232,017	.....	1,197,409
Optical instruments, including lenses and spectacles .....dut.	.....	76,857	.....	86,387	.....	820,500	.....	758,337
Sheet and plate glass—								
Cylinder, crown, and common window glass, unpolished .....lbs. dut.	5,604,745	350,399	6,581,625	331,759	11,596,192	909,942	35,606,904	1,773,255
Plate glass, cast, polished, unsilvered, sq. ft. dut.	261,433	214,388	538,576	227,331	2,946,579	2,640,122	3,226,654	1,672,991
Plates or disks, rough-cut, for optical purposes, lbs. free	128,718	100,092	44,499	19,741	865,772	814,341	189,417	202,934
All other .....dut.	.....	187,776	.....	201,893	.....	2,056,007	.....	1,850,242
Total	.....	$1,065,967	.....	$1,036,272	.....	$8,765,472	.....	$7,719,805

EXPORTS

Glass and glass products (total)	.....	$1,414,880	.....	$707,396	.....	$22,290,539	.....	$6,426,541
Plate and window glass—								
Window glass, common, boxes (50 sq. ft.)...	1,766	15,543	3,796	18,117	331,190	2,337,419	16,514	98,759
Exported to—								
Canada	56	507	62	259	141,783	919,412	791	7,030
Mexico	390	4,536	1,812	8,038	32,542	268,814	7,402	41,141
Cuba	240	1,779	1,640	7,200	30,679	237,756	3,369	17,419
Argentina	.....	.....	.....	.....	23,000	140,020	.....	.....
Brazil	.....	.....	.....	.....	17,362	120,067	2	20
Chile	50	450	10	140	7,928	51,773	61	793
Uruguay	.....	.....	.....	.....	13,556	87,616	.....	.....
China	.....	.....	.....	.....	5,135	38,429	42	560
Japan	.....	.....	.....	.....	10,367	84,489	1	15
Australia	134	1,182	.....	.....	6,955	48,829	.....	.....
New Zealand	.....	.....	.....	.....	944	9,100	13	125
Other countries	896	7,089	272	2,480	40,939	331,114	4,833	31,656
Plate glass, unsilvered, sq. ft.	111,647	68,100	275,678	121,286	2,564,345	1,942,988	1,689,246	784,564
Wire glass, sq. ft.	.....	.....	17,464	5,875	.....	.....	83,619	16,025
Other window and plate glass, n. e. s. ...lbs.	.....	.....	218,448	22,330	.....	.....	466,794	45,368
Glass containers (bottles, vials and jars)....lbs.	.....	408,080	2,873,098	168,477	.....	6,854,157	.....	1,763,747
Table glassware, plain .....lbs.	.....	.....	720,779	91,127	.....	.....	1,507,977	209,296
Table and other glassware, cut or engraved..lbs.	.....	24,450	30,863	15,752	.....	301,717	.....	91,110
Glassware for lighting—								
Lamp chimneys and lantern globes .....lbs.	.....	.....	129,907	27,239	.....	.....	327,139	68,653
Globes and shades for lighting fixtures...lbs.	.....	.....	83,400	29,787	.....	.....	286,647	88,942
Lamps and other illuminating devices, chiefly of glass .....lbs.	.....	.....	139,482	45,626	.....	.....	316,215	125,246
Chemical glassware .....lbs.	.....	18,664	13,470	9,009	.....	239,716	.....	118,876
Electrical glassware, except for lighting....lbs.	.....	.....	82,475	16,071	.....	.....	349,664	51,313
Other glassware, n. e. s. .....lbs.	.....	880.043	1,833.238	136,700	.....	10,614,542	.....	2,964,642